POWER

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Lost Opportunity

Contributed by H. D. ODELL

THE chief engineer was an intelligent and industrious young man, a correspondence graduate. Although only 25 years old, he had already put in eleven years at the game, having entered the engineering field as an oiler in an electric-light plant. In two years he was promoted to the position of night engineer. Attentive to his work and courteous to all, he made friends and a great future was predicted for him. At the age of 25 years he had realized his ambition and was a full-fledged chief engineer in charge of a street-railway power plant. But there was one thing that had never been impressed on his mind and that was "'never to accept favors from drummers."

THE manager of this railway system was a clean-cut, intelligent person and a first-class judge of men in general. This power plant was one of a string of six owned by a syndicate, and the manager was so efficient that the syndicate appointed him general manager of all six plants with headquarters in a larger city. Of course he had to employ a man to take his place in the position he was going to give up. He thought the young chief would make good if given a trial, but he wanted to find out a few things before deciding. He walked into the power house the next evening and, not finding the chief, was told that he was at home and decided to call on him there. He was invited in and found the chief taking down short-hand from his wife's dictation. He expressed his surprise, and the chief told him that he had been studying office work by correspondence for over a year. The manager was so well pleased that he almost told the chief of his intended promotion, but his better judgment prevailed and he decided to try him on honesty first. So, after talking about several proposed changes to be made at the plant, he left. Next day the manager called an oil drummer by 'phone and asked him to visit the chief and try to sell him some oil. The drummer did so, but the chief told him that he only made requisition to the manager, who acted as purchasing agent. The drummer said that he was anxious to place his oil at the plant and that if the chief would use his influence he would divide his commission with him. As he left he shoved a five-dollar bill into the chief's shirt pocket, the latter objecting rather weakly.

The manager visited the power house next evening and after talking with the chief for a while, asked him how his oil supply was and if he would need any soon. The chief stammered and said that he had plenty. The manager left, looking sad.

SEVERAL days later the drummer appeared again and told the chief that the chance he had waited for so long had come and he wanted to get his oil placed in the plant and would pay the chief well. He then said that the manager was going to be promoted and that a new man was to take his place, and when the change was made he expected him to purchase his oil. It would be easy, he said, as the new manager would not be familiar with the run of things for several weeks and the chief could make the change from one oil to the other without any danger and make some velvet besides. When he left he gave the chief $20 and did not have to push it into his pocket.

NOT knowing that he had been selected for the manager's position, the chief fell for the whole plan and upon reaching home told his wife that his influence was beginning to be recognized and then told her the whole story. Her woman's intuition almost saved him, for she begged him to take the money to the manager and order the drummer to keep away from the plant. She told him that the manager might promote him and wanted to know why he had been studying office work evenings for the past year if he did not expect to advance by the knowledge he gained. The chief maintained that the manager had nothing for him or he would have spoken to him before about the change.

The manager appeared at the plant again the next day to give the chief a chance to redeem himself, but the latter would not talk much, and as he felt guilty, he was glad when the manager had gone.

The manager left, a new man took his place and the oil deal was made two weeks later. The first of the next month when the general manager made his visit to the city, he called on the chief and told him he had heard of his little deal in oil, but that he had not entirely lost faith in him and was going to give him a chance to be honest. Then he told the humiliated chief of the opportunity he had lost for advancement.

Spontaneous Ignition of Bituminous Coal

By J. F. SPRINGER

The author explains how the spontaneous ignition of bituminous coal occurs; cites the results of experiments made to determine conditions favorable and unfavorable to self-firing; gives tests by which to find out whether a certain coal is likely to ignite spontaneously; and points out methods of storing coal to prevent such action.

BITUMINOUS coal will often take fire without the application of a flame. This action is called spontaneous ignition or, more commonly, spontaneous combustion. In times past it was largely a mystery, and even at the present day it is not thoroughly understood in all its details; however, scientific men have learned enough about its causes to remove the cloak of mystery.

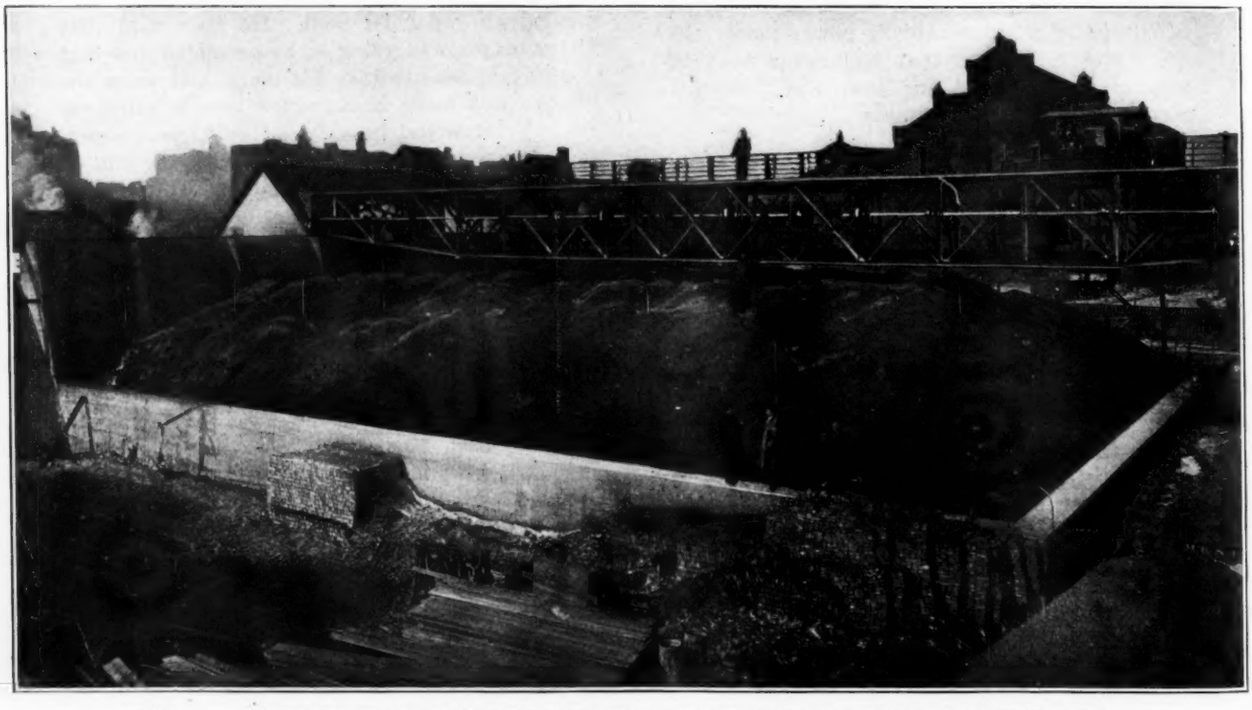


FIG. 1. CONCRETE COAL-STORAGE PIT OF THE OMAHA ELECTRIC LIGHT AND POWER CO.

Spontaneous ignition is believed to occur as follows: Bituminous coal exposed to the atmosphere absorbs oxygen slowly, and as a consequence of the oxidation, the temperature rises—slowly, perhaps, but nevertheless the coal gets warmer. Now, the higher the temperature of the coal the more rapidly will oxygen be absorbed from the air, and the more rapid the absorption of oxygen the faster will the temperature increase. Thus, each action accelerates the other until the temperature eventually reaches the point at which the coal will ignite, and spontaneous combustion ensues.

No external application of heat is necessary, though it will doubtless hasten spontaneous ignition. External heating—not necessarily at a high temperature, either—may start spontaneous combustion. For example, coal stored against a furnace wall or over a steam pipe may ultimately take fire spontaneously, although it would have remained safe from such eventuality if the furnace wall or the steam pipe had been absent. It is possible that, under favorable circumstances, coal that is merely warm when stored may develop spontaneous combustion. In the Cape Breton mining region in Nova Scotia the coal piled in heaps on the surface in the winter does not develop spontaneous combustion; but the very same coal stored in Montreal in the summertime in piles of less height is subject to spontaneous firing. It would seem as though the very moderate temperature of the coal due to the summer weather is sufficient to start spontaneous combustion.

Doubtless some coals are much more subject to self-firing than others, so that the conditions which result in no harm in one case will make all kinds of trouble in another. Anthracite seems to be proof against spontaneous combustion; it is bituminous coal that causes difficulty, and some grades give more trouble than others under the conditions of storage.

A very simple test may be applied to determine whether a coal is likely to ignite spontaneously. If it results unfavorably, great care should be taken in storing that particular coal. If the test results are only moderately favorable, caution should still be exercised. One form of test is as follows: Take a convenient quantity of the coal and weigh it pretty accurately. Heat the sample to 250 deg. F., hold it at that temperature for three hours, and then weigh it. If the weight has gone up 2 per cent. or more, the coal is a dangerous one, from the point of view of spontaneous combustion. The sample must be dry coal, the drying being done at about 100 deg. F. During the test a tem-

perature of 250 deg. could be maintained by using a steam coil containing steam at a pressure of 15 lb. per sq.in., gage. Another simple form of test is as follows: Shake one grain of finely pulverized coal for five minutes with 20 c.c. (1.2 cu.in.) of a half-normal solution of bromine. Bromine has a bad smell. If the sample, at the end of the five minutes, has absorbed the bromine and destroyed the smell, then the coal is to be regarded as a dangerous one to put in storage.

The depth of a pile seems to have a good deal to do with the development of spontaneous combustion, according to experiments made in France some years ago. A pile of slack coal was constructed in such a way that its height or depth varied from nothing at all up to 20 ft. The length was 130 ft., and the width at the top was about 3 ft. This pile was under observation for some three months, and every day tests were made at points in its length, to determine temperature conditions down in the pile. The points tested varied in respect to their distance from the bottom; the deeper the pile the greater this distance. Disregarding the low end of the pile, the temperature rose pretty steadily from the beginning to the end of the three-month period. The temperature never got higher than about 160 deg. F. between the low end of the pile and a depth of about 13 ft. From a depth of 13 ft., the temperatures went up until at the deep end of the pile spontaneous combustion took place.

There is reason to believe that for each and every coal there is a certain safe depth of pile which should not be exceeded. A 10-ft. pile is very likely safe for most bituminous coals, provided other conditions are not unfavorable; but 20 to 25 ft. is probably more or less dangerous for most coals. The New York Edison Co. has a big storage yard at Shadyside, N. J., where coal is stored in long piles which reach heights up to about 35 ft., and spontaneous combustion gives trouble at this yard. In fact, it is probable that most consumers who pile coal to heights exceeding 20 ft. have more or less trouble.

The oxygen absorbed by the coal is taken from the air in the spaces between the lumps, but it has been pretty well established that the amount of oxygen contained in these spaces is too little to account for the total absorption from the moment of storage up to the moment when the coal takes fire. If this is really the case, then there must be a circulation of air into and out of a coal pile. It has been estimated—for a particular case—that an entire change of air takes place once every 9½ hours, which would mean a very slow movement of air. An experiment with a coal pile having a cover with openings that could be closed showed that the temperature rose and fell as holes were opened and closed, respectively. That is to say, when the air supply was cut off, the coal cooled; and when air was admitted, the coal heated. This seems to indicate that if coal could be stored in an air-tight chamber, spontaneous combustion would not develop.

Fine coal is especially susceptible to self-firing, probably because there is much more surface exposed to the air in a ton of fine coal than in a ton of coarse. Wherever air touches the surface of a piece of coal, there is opportunity for the coal to absorb oxygen; so, the larger the surface, the greater the absorption of oxygen and the higher the rise of temperature. It is therefore disadvantageous to have a part of the coal in the form of dust or very small pieces. Such fine coal will naturally sift toward the bottom of the pile, which is a bad position; for it has already been pointed out that deep piles heat up more rapidly than shallow ones.

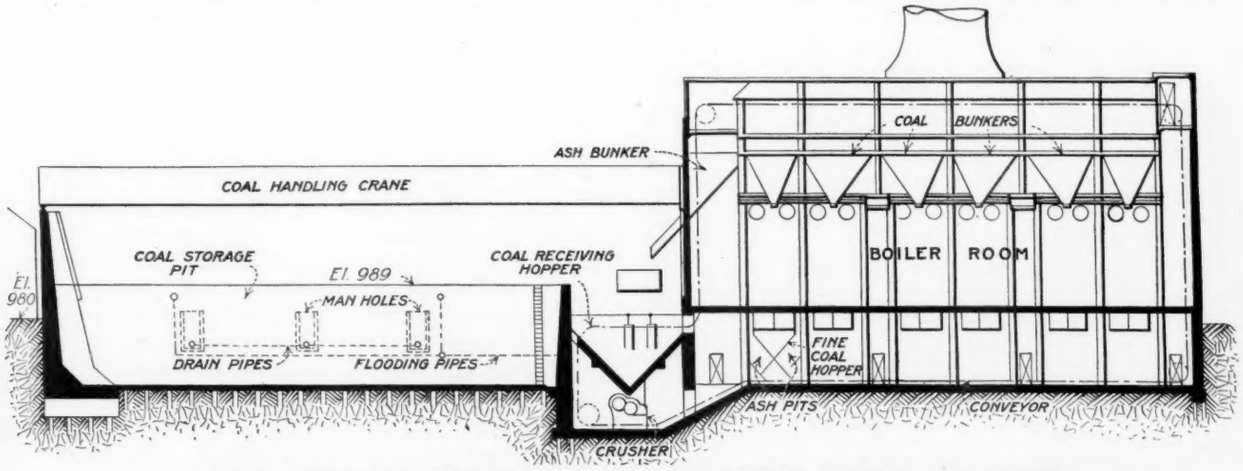


FIG. 2. SECTIONAL VIEW OF STORAGE PIT, RECEIVING HOPPERS, AND PLANT

The circulation of air through coal appears to have a double tendency. First, the circulation continually supplies oxygen, increasing the rate of absorption and consequently the temperature; that is to say, the circulating air tends to promote spontaneous combustion. Second, the circulation of air tends to cool the coal and so operates to retard spontaneous combustion. As these tendencies are opposed, it is necessary to know which will have the upper hand, and that introduces a serious element of doubt. The safe thing to do is to put no dependence upon air made to circulate through a coal pile. It may bring trouble, instead of warding it off.

Another matter that is somewhat obscured in doubt is the effect of storing wet coal. Those who have made inquiries or who have had experience of their own do not seem to be agreed. About a score of years ago in Australia, an experiment was made to obtain information on this matter. Each of two similar bins, placed side by side, was charged with 245½ tons of the same grade of small coal. There was a roof over the bins, but surface ventilation was supplied, and the sides of the bins were of boards with the cracks left unstopped.

In the one bin, the coal was put in dry; but during the loading of the other a stream of water was played on the coal, which was made thoroughly wet, as was indicated by the leakage of water from the bin. Temperature observations were made from day to day in both bins. The temperature of the interior of the dry coal rose steadily until in about sixty days it reached 392 deg. F. in the central part of the coal. The experiment was then halted for fear of actual firing. The coal that was stored wet also increased in temperature until a maximum of 138 deg. F. was reached, after which time the temperature fell.

Paymaster G. R. Crapo of the United States Navy, with an experience gained in a subtropical climate, says

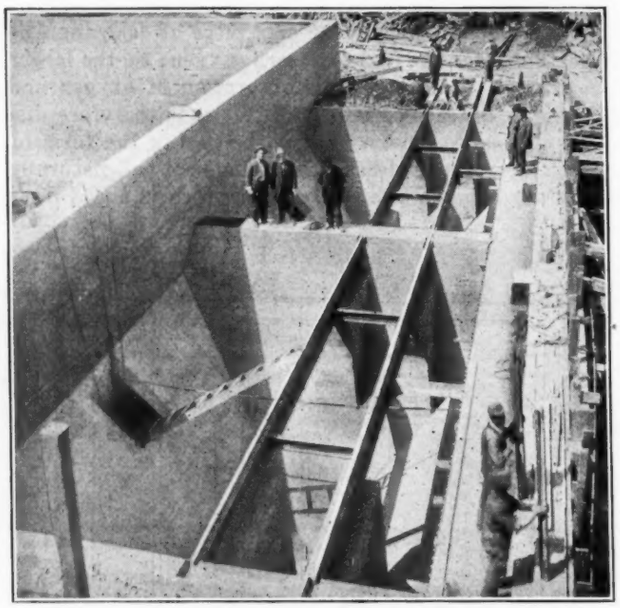


FIG. 3. RECEIVING HOPPERS FOR COAL

that he has handled coal both wet and dry and has discharged vessels in a downpour of rain. He says that fires have occurred with coal stored in both ways, but that less trouble has been experienced with coal stored wet. But this is not the end of the story. A British investigation, by J. I. Graham, resulted in the following conclusion: "At temperatures below 122 deg. F., coal dust, when moist, absorbs oxygen at a rate approximately half as great again as dry dust." This means that under such conditions spontaneous combustion would be markedly promoted. J. Ashworth, lately of Vancouver, B. C., reached the conclusion, presumably from observation and information, that moisture had to be considered and that no gob fire in a mine would take place if the mine were dry and particularly if the air were dry. In years gone by, he was connected with a colliery where the gob heated up and where the coal when stacked above ground was subject to spontaneous firing. He notes that this self-firing "generally occurred soon after the first heavy shower of rain." What is to be concluded in this matter?

An investigation of Illinois coals seems to have favored, for those coals at least, the idea that wet coal is dangerous. "Any coal with conditions favorable to oxidation will be facilitated in that action by moisture. Without exception, in all the series of tests, the wetting of the coal increased the activity, as shown by the ultimate temperature."

The truth of the matter probably is that a little water will promote spontaneous combustion, but that a great deal will check it. But how much is "a great deal"? Is a generous sprinkling, as in the Australian experiment, sufficient? Or must there be complete submergence in a body of water? There seems to be no recorded case of self-firing originating with a coal that was fully submerged in water; but if the coal is merely damp or lightly sprinkled with water, it is probably in a dangerous condition. Old coal mixed with coal freshly mined is understood to be a dangerous combination.

There may exist an impression that spontaneous combustion seldom occurs. In contradiction of this idea, it is on record, according to the officer in charge of the coaling plant, that at the United States Naval Station at Key West, Fla., sixteen cases of spontaneous combustion occurred in a period of less than 100 days. This was during the winter of 1914-15 at this subtropical location. The Canadian Pacific Railway's big storage yard at Montreal has been productive of repeated trouble from spontaneous combustion. The Chicago & Alton R.R. some years ago had a coal-storage pile 10 ft. high, containing a considerable percentage of slack. Notwithstanding the moderate depth, this pile took fire in several places.

Fires due to spontaneous ignition apparently do not occur on the surface; they occur down in the coal. A lighted match or a cigar stub could not very well account for a deep-seated fire. Spontaneous combustion is a real danger in connection with coal storage and can no longer be doubted or ignored. The thing to do is to provide against its occurrence.

There is at least one certain and sure method—complete submergence of the coal in water. Such submergence operates in two ways. In the first place, it cuts off the oxygen supply, which is most important. As the coal cannot get oxygen, there will be no absorption of this gas and no consequent heating. In the second place, the water is sufficient in amount to keep the temperature fairly uniform. There can be no spontaneous combustion unless the temperature rises to the point at which coal takes fire, known as the ignition point.

Complete submergence is neither unheard of nor unused. The United States Navy is using submergence for large quantities of coal at the coaling stations at the Atlantic and Pacific ends of the Panama Canal. Depressed storage floors are provided at both points, and the arrangements are such that from 20 to 30 ft. of the bases of the coal piles on these floors is submerged in salt water.

The Underground Railways of London have an electric generating station at Lot's Road. Here a tank for totally submerging coal in quantities up to 15,000 tons has been constructed and put in operation. The tank is of steel and is operated by means of their existing coal-handling equipment. The company has dry storage in addition.

An interesting example of a submerged-storage pit for bituminous coal is that of the Omaha (Neb.) Electric Light and Power Co., in which 6000 tons can be stored under water. Fig. 1 is a general view of the storage pit filled with coal, showing also the crane by which the coal is handled. Between the pit and the

power house are two receiving hoppers over which runs the railway siding. A longitudinal section of the plant and pit is shown in Fig. 2. The pit is built of concrete, with walls 22 ft. high on three sides. On the fourth side the wall is 16¾ ft. higher. This high wall parallels the west side of the power house and not only forms one of the sides of the pit, but also serves as a fire protection for the near-by plant of the Omaha Ice Co. and supports one rail of the crane runway. The other rail is carried on a girder along the side of the power house.

The two receiving hoppers, shown in Fig. 3, are of reinforced concrete, and each has a capacity of 50 tons. The function of the receiving hoppers is to receive coal that is to be consumed at once. As the railway track is directly overhead, it is only necessary to spot the cars at the proper points and make delivery by gravity, with or without the assistance of men. Coal going into storage is taken from the cars by a grab bucket on the crane. As the crane spans both track and pit, the coal may be readily delivered at any desired point. The span of the crane is 143¼ ft. from center to center of wheels. The grab bucket has a capacity of 1½ cu.yd., and the lifting power of the crane is 5 tons. This handling device is guaranteed to deliver 50 tons of coal per hour from the car to the center of the pit.

Walls and Floor Rest on Piles

The site of the pit is underlaid by quicksand, and so the walls and floor are carried by piles. Apparently all the floor piles, and possibly the wall piles also, reach down to rock and accordingly act more as columns than as piles. The pile heads terminate just beneath the floor, and each is surrounded by a square cap of concrete 2½ ft. on a side and 1 ft. thick. In estimating the loads, the engineers placed the full load on the piles and none on the soil between the piles. There is a certain amount of reinforcement in the floor slab. At the same time it is not a part of the design that the floor shall withstand an unbalanced upward pressure of water beneath it. There is such a pressure, especially when the river is in flood, but the downward pressure of the water and coal in the pit operates against it.

A recent pit for submerged storage is the one built for the Duquesne Light Co. on Brunots Island at Pittsburgh[1]. This pit is 150 by 800 ft. in plan and 25 ft. deep. The bottom is horizontal, but the sides slope at an angle of 45 degrees.

A blanket of carbon-dioxide gas would probably be quite as effective as submergence in water for preventing spontaneous ignition. Such a blanket might be relied upon to remain in the tank because of the fact that its specific gravity is greater than that of air; but it might be necessary to extend the sides of the tank a few feet upward to prevent dissipation of the gas by passing currents and the like.

The things to be done when spontaneous combustion occurs are to dig out the fire and either burn the affected coal at once or remove it to a safe place. Flooding with water is not advisable; for the coal over the fire may coke, and form a dome-like shield capable of affording a good deal of protection against water. At Shadyside spontaneous combustion is dealt with by digging out the fire and sending the affected coal to the power station.

[1]See *Power*, page 650, Nov. 13, 1917.

Power-Plant Measuring Instruments

By H. Taylor

Plants of, say, 150 hp. or less are as a rule the ones where the absence of measuring instruments is most noticeable. Picture, if you will, such a plant consisting of one 150-hp. horizontal return-tubular boiler operating under forced draft, one pump feeding through a closed feed-water heater, and one injector for emergency use; one 100-hp. automatic cutoff, high-speed engine belted to a lineshaft and one little air compressor tucked away in a corner where no one can get at it, trying its best to do the work of a 50 per cent. larger machine.

The tools usually supplied to such a plant consist of the following: The remains of a No. 7 scoop shovel; one fire hoe with the blade badly burned and loose on the handle; one garden hoe with handle split, to be used for cleaning the ashpit; one iron body wheelbarrow with a large hole eaten through the bottom and one leg loose; a few broken wrenches, a hammer and an old tomato can to fill the oil cups with. The engineer must be on duty at 6:30 a.m. in order to have power on at 7 a.m. He must wheel his coal about fifty feet to the boiler room, do his own firing, including cleaning fires from stationary grates twice during the ten-hour run, and then wheel away the ashes in all kinds of weather. He is responsible for and must look after the boiler and engine plant throughout the entire day and occasionally repair a steam line or splice a broken wire in the mill.

This type of plant is more common than some of us believe, perhaps. Suppose this is the type of plant I am about to take charge of. I get after the manager as follows: "Mr. Manager, I have come to ask your coöperation to the extent of purchasing the necessary implements and instruments that I may conserve fuel, oil and other supplies, thus aiding the Government and benefiting yourself—first of all, a set of good tools, a list of which I submit herewith, that I may be able to do my work quicker and better, thereby giving me more time to study the peculiar needs of the plant. Next, I will need a thermometer to put on the feed line to the boiler—the cost is trifling compared with its value—a boiler-room scales and a water meter, that I may be able to weigh the coal and measure the water to determine whether I am getting a reasonable water evaporation per pound of coal. I would then suggest a gas-analysis instrument to find out whether we are getting the benefit of the greatest number of heat units possible. By the aid of these tools and instruments I can get the boiler plant working more efficiently and save many pounds of coal. For the engine room I will need a few suitable oil cans to save gallons of oil which today costs 'real money.' After making steam economically, we should not fail to use it economically, therefore I will ask you to purchase a good steam-engine indicator that I may make sure the engine valves are set properly and not wasting steam.

"With the aid of these instruments we can tell from day to day just what our power costs, and I feel certain we can reduce that cost, thereby conserving coal and saving money for the company. Now, Mr. Manager, just one more suggestion. If you will allow me access to the vouchers pertaining to my department I will be able to prepare a tabulated cost sheet of the whole power plant."

Underground Steam Mains

By CHARLES L. HUBBARD

This article treats of tunnel and conduit construction. Various types of conduits selected from those in common use are described. Wood conduits are still extensively used where it is desired to avoid the expense of concrete and tile. Insulation of piping.

ONE of the most important details connected with underground steam mains is the form and construction of the conduit. This serves the purpose of protecting the pipe from moisture and also forms a part of the insulation for reducing heat loss. In some cases, as with wooden conduits, both of these offices are combined to a large extent in the same casing, while with those of masonry the walls of the conduit only serve as a protection to the special insulation which surrounds the pipe, tile or concrete in itself offering a comparatively small resistance to the transmission of heat. The forms of construction shown have been selected from those in common use, with the idea of illustrating different types. Some of them are patented, while others have come into general use through the experience of various engineers.

Various Kinds of Wooden Conduits

Wooden conduits, the oldest type, are still extensively used where it is desired to avoid the expense of concrete or tile. With some of these the wooden casing forms both protection and the only insulation, while in others an additional insulating filling is placed around the pipe inside the conduit. The life of a wooden conduit depends largely upon the quality of the wood employed and the nature of the soil in which it is laid, whether wet or dry. A typical conduit or casing of this kind is shown in Fig. 1. The main body in this case is composed of a thick wooden wall lined with bright tin and protected on the outer surface by a coating of waterproof asphaltum cement. Solid turned logs are employed for pipe sizes up to 6 in.; larger sizes are built up of staves, put together with mortise-and-tenon joints, coated with a creosote preservative and strengthened with heavy galvanized wire. The thickness of shell varies from two to four inches, according to requirements. The sections are made in lengths of six to eight feet, cylindrical in form, with space inside for rollers and supports. Wood casings of this type have been known to give thirty years of service. Fig. 2 is a section of a conduit of this kind, showing its make-up and method of drainage.

Porous-tile drain pipes are laid below and at either side of the conduit, with a layer of crushed stone between to prevent surface or ground water from settling around the casing. This is an important detail of conduit work, especially where wood is used, as the length of service depends largely upon the degree of dryness which is maintained. Another wooden conduit is shown in Fig. 3, and consists of a tin lining outside of which are layers of asbestos, wood, corrugated paper and, finally, an outer casing of wood staves coated with asphaltum. This form has the advantage of being removable for repairs to the pipe.

A simple form of conduit, often used around railroad yards and industrial plants where the pipes are carried a short distance below the surface, is shown in Fig. 4. The box is of rough lumber, usually about two inches thick, and is set over broken stone with a tile drain below. Any water that finds its way into the conduit is drained off through holes bored in the bottom of the box at frequent intervals. The pipes are supported upon rollers strung on a stay-bolt, also serving to strengthen the box. Stiffening pieces are nailed to the sides and bottom of the box to give it additional support. The life of a wooden conduit of this type in fairly dry soil with the trenches well drained is estimated at 16 to 30 years. One trouble experienced with wooden conduits comes from the great difference in temperature to which they are exposed during the heating and non-heating season. In some cases they shrink or swell, causing serious damage, and sometimes, to avoid this, it has been considered more economical to keep steam on the mains all summer, shutting off the branches to the various buildings just inside the basement walls. The tile underdraining already mentioned appears to be necessary to long life as instances are common where conduits so protected have been found in good condition after 25 or 30 years, while those without underdraining have had to be renewed in seven to ten years.

The objectionable points mentioned in connection with wooden conduits have led to the adoption of materials that are not affected by heat or moisture, among which are brick glazed sewer piping, hollow tile blocks, concrete and combinations of these. A well-constructed conduit of masonry is practically indestructible so far as general deterioration is concerned, but is susceptible to the action of frost, the bursting of pipes, etc., which limits its useful life to that of the pipes which it contains unless it be of such form that the top may be removed without damage to the lower half.

Glazd-Tile Conduits

A common form of glazed-tile conduit is illustrated in section in Fig. 5. The lengths are made with longitudinal grooves, which allow of their being split in halves with considerable accuracy after being burned. The lower half is first laid in the trench, after which the pipe is put in place supported upon iron cradles or rollers and the space around it filled with insulating material. The cover, or upper half, is then put in position, the space around the pipe packed with insulating material, completely filling the conduit, and the joints then made tight with portland cement. One difficulty experienced with tile conduits is in supporting the pipe, as bolts cannot be used to hold the saddle in place. A simple device for a single pipe is shown in Fig. 5 and consists of filling in the bottom of a section of the conduit with concrete forming a pier 10 or 12 in. in length, in the top of which is set a piece of channel iron, forming a guide for the roller supporting the pipe. The ends of the pier are raised sufficiently to prevent the roller from falling out of place, and a gutter beneath

the pier allows any water in the bottom of the conduit to drain away. When there are two or three pipes to be supported, a saddle or frame carrying the required number of rollers may be built into the concrete base in place of the channel-iron described.

A patented split tile conduit especially adapted to extensive systems of piping is illustrated in Fig. 6. The principal feature is the method of supporting the pipe rollers and anchors by using a tee in the conduit line with the side outlet turned down and built into a heavy concrete base. The pipe support or anchor is embedded in this, as indicated in the illustration. Drainage around the conduit is secured by gravel filling, crushed stone and a tile underdrain.

A combination type of conduit used by one of the largest distributers of steam in their latest construction, shown in Fig. 7, consists of a concrete base upon which is laid a flooring and side walls of hollow tiling carried up to the center line of the pipe and on top a line of brick and over the top a half section of glazed sewer pipe. The joints between the tile in the side walls and bottom are left open to drain off any water that may find its way into the conduit. To prevent a circulation of air from tile to tile in a longitudinal

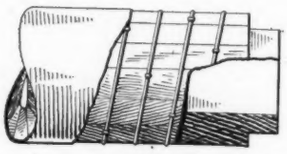


FIG. 1

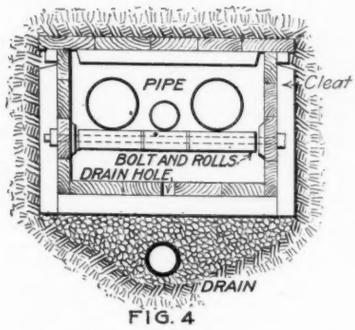


FIG. 4

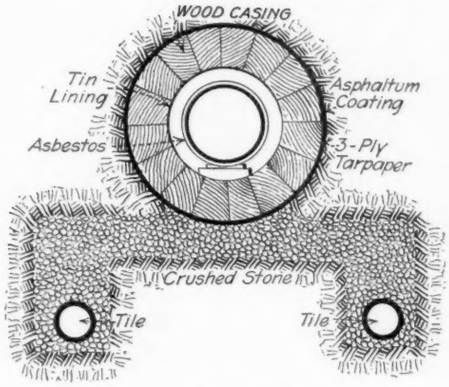


FIG. 2

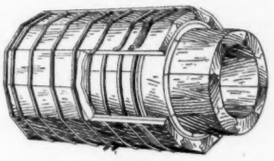


FIG. 3

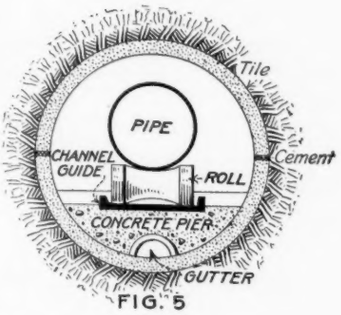


FIG. 5

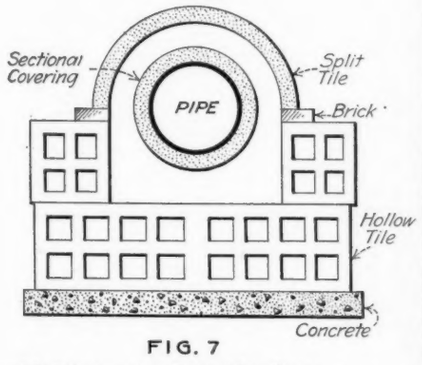


FIG. 7

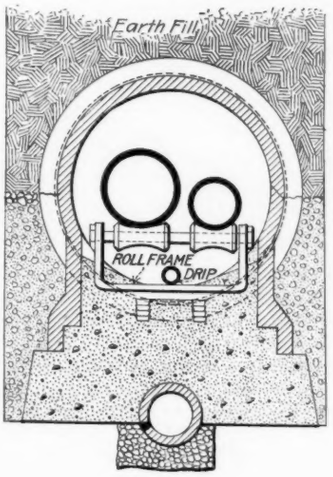


FIG. 6

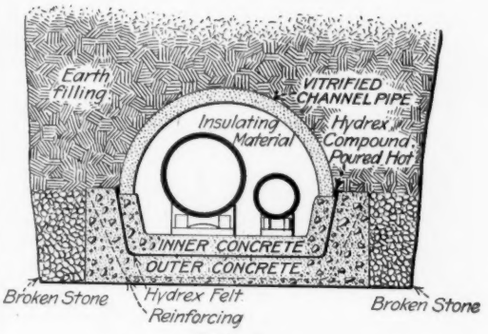


FIG. 8

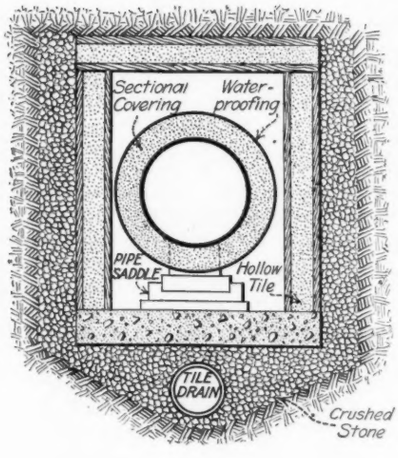


FIG. 9

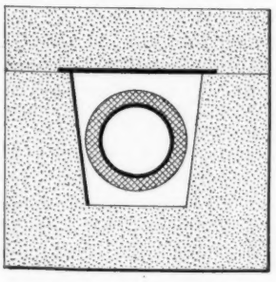


FIG. 10

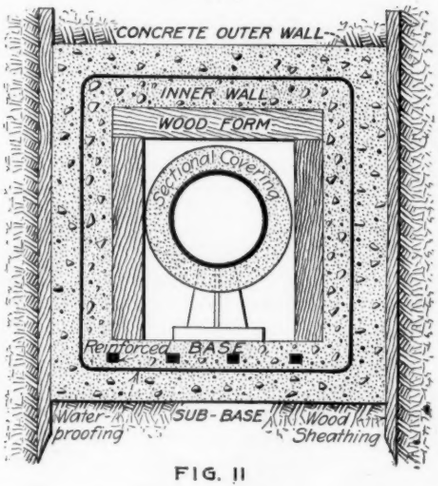


FIG. 11

FIGS. 1 TO 11. VARIOUS TYPES OF UNDERGROUND PIPE-LAYING AND CONDUIT CONSTRUCTION

direction, bricks are set up on edge between the sections, forming dead-air spaces which add to the insulating effect. The steam pipe is covered with sectional covering, and the space between it and the conduit walls is packed with mineral wool.

A patented conduit of special construction particularly adapted to wet locations is shown in Fig. 8. The lower half, which is of concrete, is first constructed and the pipes are laid, after which the tile cover is put on and made tight by a cement dam at the sides and a special waterproofing poured, while hot, into the joints. The conduit shown in Fig. 9 is similar to Fig. 7, except that the sides and top are of hollow tile laid crosswise on a concrete base; this arrangement of the tiling limits the length of the air spaces and prevents air circulation. The entire trench, except the top, is lined with crushed stone, and a porous-tile drain is laid under the center.

One of the simplest forms of continuous concrete conduit is shown in section in Fig. 10. When the trench is dug, a mold is made of boards with a core to form the slot at the center. The concrete is then filled in, forming the bottom and side walls. After this has set for about twelve hours, the core is removed and the pipe may be laid, a strip of sheet iron placed over the slot and the covering layer of concrete filled in. If the ground is likely to hold water long after rain, it is well to coat the sides and top of the conduit with hot coal tar.

There is no item of greater importance concerning underground heating mains than the protection of the piping from outside moisture. The presence of water in the conduit, especially if it reaches the piping, greatly increases both the heat loss and the deterioration of pipe and insulation, therefore conduits should be thoroughly underdrained with tile laid in coarse gravel or crushed stone, special care being taken to provide a free outlet for the drains to keep the trenches clear of water.

The National District Heating Association has recently made an investigation of different methods of underground conduit construction with special reference to waterproofing and has submitted the type shown in Fig. 11 as one of the best "home-made" arrangements when material and the degree of skill required in its construction are taken into account. In laying this conduit wooden sheathing is driven along the sides of the trench to a distance of at least a foot below the sub-base. Seepage water is kept out by means of pumps and the sub-base and outer walls poured nearly to the top, an inner form of course being used. When this outer shell has set, the inner faces, sides and bottom are brushed with hot asphaltum, a layer of felt or burlap is pressed against it and the surface again brushed with hot asphaltum as before. From four to six layers of this material are used, taking care to give it a good lap, each being joined to the previous one by brushing it over with hot asphaltum. The strips of felt or burlap are run at right angles to the line of the trench and the ends carried well above the sides of the preliminary outside walls and folded back, awaiting completion of the top, or cover. Next, the inner reinforced base is poured, the pipe installed and insulated either by a sectional covering or by packing it in some suitable insulating material. The wooden form for supporting the inner walls and top are left in place, serving as additional insulation. After the inner walls and top are poured, the felt is folded over the top, layer by layer, each being brushed with hot asphaltum as previously described. Last of all the outer or preliminary side walls of concrete are carried up and over to make a complete envelope. Although no under-drain is shown, it is always advisable to provide one if it is possible to secure an outlet at such a grade as to drain away the surface water from around the conduit.

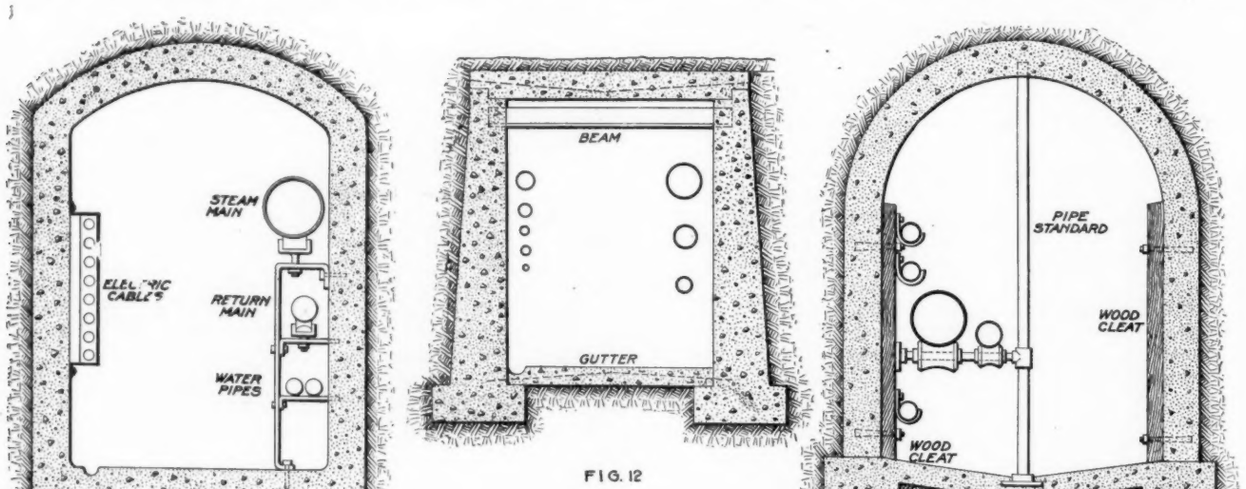


FIG. 13. FIG. 12. FIG. 14.

FIGS. 12 TO 14. TUNNEL DESIGN AND MEANS OF SUPPORTING PIPES AND CABLES

Tunnels have the advantage of accessibility to the piping, but their excessive cost as compared with conduits limits their use to special cases. They are most frequently employed in connecting buildings of an industrial plant where a considerable number of pipes and electric cables are to be put in. Tunnels were formerly constructed of brick, but reinforced concrete is now employed almost exclusively. One form is illustrated in Fig. 12, having a reinforced floor and roof and monolithic side walls. The roof slabs are made in sections and cemented to the walls and are therefore

removable. The I-beams just below the roof, for attaching pipe hangers, are spaced 10 or 12 ft. apart. They may, however, be buried in the roof slabs with only the lower flange projecting. Pipes run in tunnels should be carried close to the walls so as to allow a free passage, either at one side or in the center. Fig. 13 shows a tunnel having an arched top and made of solid concrete. Special attention is called to the construction of the rack for carrying the pipe chairs, designed so that sections of the top pipe may be removed directly, while those below must be slid out from behind the front support of the rack, which is not objectionable in the case of small or medium-sized piping. Another method of supporting pipes and cables is shown in Fig. 14, in which pipe standards are erected at the center of the tunnel and cleats are bolted to the wall opposite the standards. Heavy piping is carried on horizontal supports attached to the standards and cleats, while small pipes, cables, etc., may be carried on hooks or other devices fastened directly to the cleats. Special care must be taken in the insulation of tunnel piping and the ends of the tunnel should be tightly closed to prevent any circulation of air which would tend to increase the radiation losses.

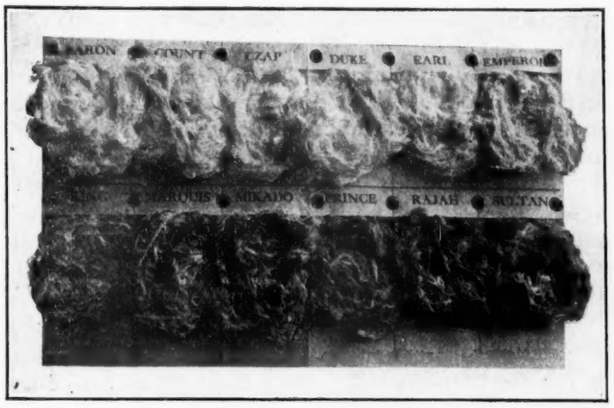
When considering the insulation of a pipe, the entire covering, including the conduit, must be taken into account. Where pipes are carefully packed with suitable nonconducting material and incased in tile or concrete, the efficiency will be somewhat more than for sectional covering, owing to its greater thickness. Conduits of this kind are usually made of such size that the thickness of the insulation shall not in any case be less than three inches, which should bring the efficiency of the entire conduit up to 90 or 95 per cent. The insulating material for this purpose should be especially adapted to conduit work, such as granulated cork, fossil earth, asbestos fiber and ground sponge. Mineral wool may be used when the pipe is protected with some form of sectional covering to prevent the corrosive action of the mineral wool. In the case of brick and concrete tunnels the pipes should be covered with some form of sectional covering that has the property of resisting dampness as well as preventing the loss of heat, for tunnels may be dry in winter, when heat is on, but during the summer, when steam is shut off, moisture is likely to gather. The best grades of sectional covering have an efficiency of 75 to 85 per cent., which refers only to the covering on the pipe and not to the conduit as a whole. The insulating effect of the tunnel will depend largely upon the tightness of the manhole covers and the pipe openings into various buildings. If there is a perceptible circulation of air through the tunnel, the insulating effect of the walls will be neutralized, based on the principle that a dead-air space around the pipes is important in reducing radiation losses. Similarly, in tunnel construction, the circulation of air through it should be kept at a minimum.

"Royal" Family of Waste

What is cotton waste? "The answer to that is simple," say some, yes, probably most engineers. "Cotton waste is the yarn remnants from cotton mills, and we use it to wipe up power-plant machinery. Waste is waste, but what is the idea of the question?"

Waste is not waste; there is as much difference in the grades of cotton waste as there is in shoe leather. As a matter of fact there are many grades of cotton waste, and that which is suitable for one kind of work is not good for another. A good waste should be standardized as to quality, and that is what the Royal Manufacturing Co., Rahway, N. J., has done in the production of twelve grades of cotton waste. Six of these grades are white and six are colored. The illustration shows the sampling catalog on which are mounted a sample of each of the twelve standard grades manufactured by this company. The upper row represents the white and the lower the colored grades.

When an engineer receives this sample card he orders a 100-lb. bale of, say, Duke. Some time later he orders a second bale of the same grade, and it will be the same in quality as the first order because each grade of waste is made from the same prescribed grades of materials which are procured from cotton mills that manufacture a certain grade of cotton or yarn cloth.



SAMPLE CARD OF ROYAL WASTE

A high-grade waste will not leave lint on a machine after wiping it, and it will have the maximum capacity for absorbing oil. A poor grade will possess just the opposite quality. In order to know how to intelligently purchase waste an engineer must know to what use it is to be put and he must also be somewhat acquainted with the grade of waste that is made by the manufacturer of whom the purchase is made.

Some prefer clean white waste, which, of course, is made from white raw material; others favor the use of colored waste, which is made from yarns which have been dyed in various colors. One reason for the preference for white waste is that after it has been soiled the user is more likely to open it up, bringing the clean portion to the outside. thereby using all clean portions before throwing it away as too dirty to use. Colored waste has a soiled appearance to begin with and is likely to be thrown away before it has been thoroughly used; therefore, when purchasing waste a consideration of the type of men who will use it is of importance.

Referring to the illustration, the grade designated as Baron is a fine, long-fibered, high-grade waste suitable for polishing varnished surfaces, etc., and is not recommended for general use. Grades Count and Czar are high-grade wiping wastes and Duke and Earl are for general-utility work and fit the pocketbook as well

as the requirements of the purchaser. Emperor grade, although it can be used for wiping purposes, is really not suitable for such work, because it does not give the service, being coarse in texture and is somewhat dirty to begin with. It is usually employed by oil companies for mopping up oil.

The best grade of colored waste, King, is equal in quality to Czar and Duke grades of white waste, at the same price. King and Marquis are for general wiping and are used largely by railroads, as well as in power plants. Mikado and Prince are for general-utility work and Rajah is for rough work such as putting into the journal boxes of railroad rolling stock. Sultan is in the same class as the white Emperor, both being of a low order of the Royal family, being fit only for dirty work. Sultan is for use in foundries for protecting the hands of the workmen when handling the ladles of molten metals, etc., and for starting fires.

Having determined on the grade of waste wanted, the engineer is also interested in knowing how much will be delivered with an order for a 100-lb. bale. That is, how many pounds of burlap, paper and iron hoops is to be paid for at the price of waste. Here is what he receives in the Royal brand of, say, a 100-lb. bale: First, 94 lb. of waste, it does not matter what grade, is weighed in a basket. The burlap wrapper paper and iron hoops are also weighed, the total for each bale being just 6 lb. After the waste has been pressed in a bale, it is again weighed and if there is a gain or loss in weight enough is taken from or added to the bale to bring the total weight up to 100 lb. Therefore the tare on every 100-lb. bale of waste in just 6 lb., no more and no less.

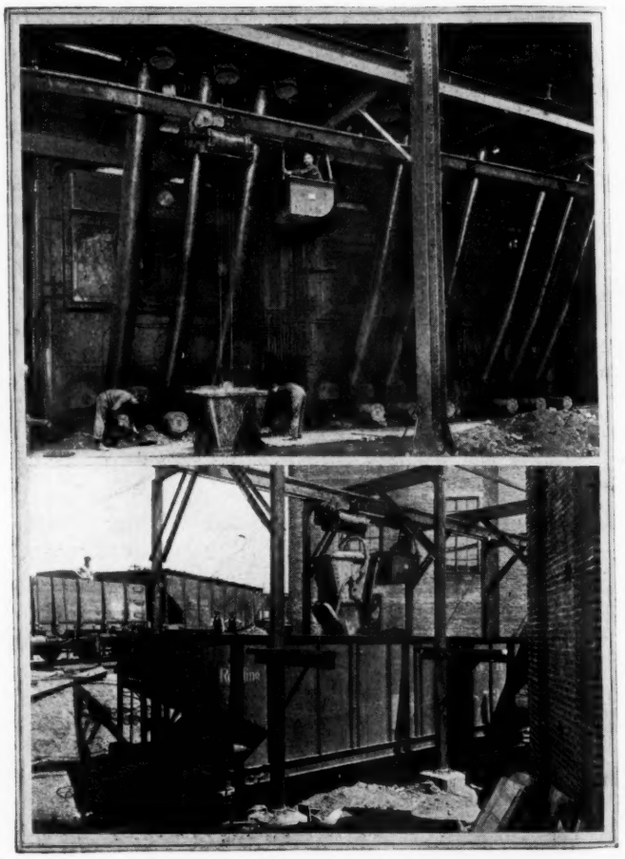
This waste is put up in bales of 25, 50, 100, 250 and 500 lb., but in each case the tare is 6 per cent of the total weight. With this standardization of the bale the engineer knows just how much useless material he is getting with his waste; in some instances with certain dealers the tare runs as high as 14 per cent. of the total weight of the bale.

All raw waste material of the Royal brand is hand-picked and screened; the yarn that goes to make up the grade of finished waste is thoroughly mixed by hand, and the mixture is machined twice to give uniformity of texture. This applies to all grades except the lowest grade of colored waste.

Mono-Rail Hoist Handling Ashes

A few years ago, in most cases ash-handling machinery was "conspicuous by its absence" and the ashes were almost allowed to take care of themselves, so that designing machinery to handle them in old boiler houses is an undertaking that must be viewed from a number of different angles. The device adopted must save labor; its first cost and maintenance must be low, and it should never entail a lot of changes in the old building, with the consequent expense. A mono-rail electric hoist with a bottom-dumping bucket lends itself readily to such installation, especially where the ashes are pulled out on the boiler-room floor. The illustrations show a Link-Belt Mono-Rail Hoist of this type that is giving excellent results in the plant of the Philadelphia Paper Co.

This machine runs on the lower flange of an I-beam track and is operated by a man riding in a trailer cage, who controls the raising or lowering of the bucket as well as the travel of the hoist. The track runs through the boiler house and continues on out over a railroad car on the siding. Laborers fill the bucket, and the operator then hoists it and runs it out over the car, and dumps it by the motion of a lever in the cage. The current required is very small, and the saving in time and labor by this method compared with that of wheeling the ashes is notable. In this instance the superintendent designed his own track supports. It is evident that while he did the work quite cheaply, he made a thoroughly good job of it. About thirty tons of ashes are handled daily, pulled out every six hours. Two men do the work of shoveling into the bucket, and



TYPICAL USE OF MONO-RAIL HOIST

at times one of them gets into the cage and runs it out over the car; at other times, to hurry the work, an additional man operates the hoist, remaining in the cage. The bucket holds 1¼ cu.yd. and is handled by a two-ton hoist. The machine is very compact and requires little headroom, and all the gears are entirely inclosed in housings and operate in oil.

In places where an overhead coal bin cannot be installed for lack of space, it may then be practicable to use the same mono-rail system to handle the coal as well as the ashes, using either the bottom-dumping or a tipping bucket to discharge coal into the stoker hopper as the case may require, or, sometimes better even, a bucket with a small chute and undercut gate is often used. This problem of handling ashes mechanically is daily becoming more urgent, as many plants are now running twenty-four hours a day where two

years ago they were running only ten; hence they have over twice the ashes to handle, with labor scarce. Many plants have stokers and forced-draft systems put in to increase their capacity, without providing for the handling of the ashes.

Some Old Firebox Boilers

BY R. E. MCNAMARA

The illustration, Fig. 1, represents one of two firebox type of boilers recently removed from one of the power houses of the Calumet & Hecla Copper Co., Calumet, Mich., the combination of size, age, design and serviceable condition being so unusual as to merit a few words of description.

These boilers are 84 in. diameter, 34 ft. 9¾ in. long and have 52 sq.ft. of grate surface, two 6-in. safety valves and double firebox. Being about forty years of age, they have been discontinued from service, although a test strip cut from one of the shells showed practically no diminution on tensile strength or elongation.

One of the unusual features is the quintuple-riveted butt joint and the rigid head bracing; even in the modern boiler nothing is found, as a rule, above the quadruple butt joint with 94 per cent. efficiency; and when it is considered that this boiler was built in 1878, not only was it a leviathan for its time, but it represents engineering and boiler-making practice which, to say the least, is by no means universal even at the present day. The firebox or furnace of one of these boilers partly demolished is shown in Fig 2.

In explanation of the apparent longevity of these boilers, it might be noted that one of the contributory

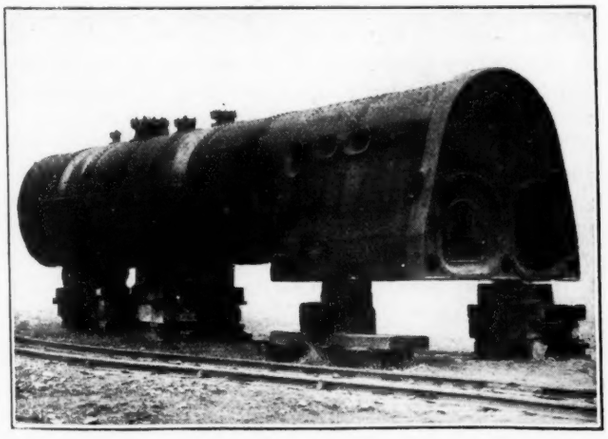


FIG. 1. FIREBOX BOILER REMOVED AFTER 40 YEARS OF SERVICE

factors is the remarkable purity of the Lake Superior water and the close attention in care, washing and repairs that the boilers have received since their installation.

Other similar boilers are still in use, but they are limited to comparatively low pressure; that is, around 100 lb. Other and later types in the same power house are of similar design, but are somewhat larger and are allowed 170 lb. pressure.

[Since receiving the foregoing we have obtained some additional information from F. W. Dean, mechanical engineer, formerly of Boston, Mass., and now with the Emergency Fleet Corporation in Washington. In speaking of this type of boiler, Mr. Dean expresses the opinion that the first ones of 90 in. diameter were designed in 1882 or 1883. Mr. Dean made the first drawings of the 90-in. boilers which were designed

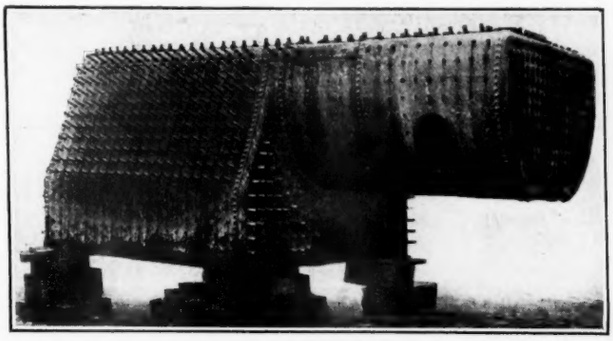


FIG. 2. SHOWING STAY-BOLTS AND TUBE SPACING

by E. D. Leavitt at his office in Cambridge, Mass., and were built by Edward Kendale & Sons of that place. The steel was acid openhearth and was rolled by the Nashua Iron and Steel Co., of Nashua, N. H. The nozzles were of steel plate rolled up and flanged, and with thick plates riveted to the flanges.—Editor.]

Steam-Carrying Capacity of Pipes

Several readers have written, suggesting that it would be of interest to know what formula was used by Mr. Thies in computing and laying out the charts for the carrying capacity of pipes, in the issue of Dec. 18, 1917, pages 825 and 826. Following is Mr. Thies' reply:

These charts were made after a careful study of an article on "Flow of Superheated Steam in Pipes," by E. H. Foster before the A. S. M. E. in May, 1917 (Volume 29 of the Transactions). These charts are good only for short runs of pipes such as mains and branches in power plants and are not figured on a basis of pressure drop. The formula is:

$$A = \frac{2.4PC}{V}$$

in which

A = Area of pipe in square inches;
P = Pounds of steam passing per hour;
C = Cubic feet of steam per pound;
V = Velocity in feet per minute;
2.4 = Constant.

The Continental heat unit, or calorie, is the quantity of heat required to raise the temperature of one kilogram of water one deg. C., and as 1 kg. is equal to 2.205 lb. and 1 deg. C. is equal to 1.8 deg. F., it is obvious that one calorie measures the same quantity of heat as does 3.969 B.t.u. This is shown by multiplying 1.8 by 2.205. It is usual when translating from the English and American standard to the Continental or metric standard of heat measure to call 1 calorie equal to 3.97 B.t.u.

A ready means of remedying leaks in engine casings is by filling cracks with litharge and glycerin.

Parallel Operation of Direct-Current Generators

By T. F. BARTON

The elements that must be considered when operating direct-current generators in parallel are discussed, and the adjustments that may be made to obtain the proper characteristics are pointed out.

ELECTRICAL generators are considered as operating perfectly in parallel when the load divides among the several units according to their rating, this proper division of the load holding as the load varies over the entire operating range of the machine. Parallel operation is considered satisfactory when this perfect condition is approximated within a small percentage.

For successful parallel operation machines must have approximately the same voltage characteristics. It is therefore impossible to operate shunt- and compound-wound generators in parallel or compound machines of greatly different characteristics, although the equalizer used with such machines tends to give each the same effective compounding.

The simplest case of parallel operation in so far as connections and electrical characteristics are involved.

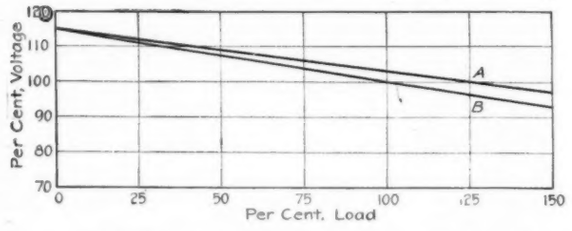


FIG. 1. REGULATION CURVES OF TWO SHUNT-WOUND, DIRECT-CURRENT GENERATORS

is found in the shunt-wound noncommutating-pole type machine, Fig. 4. If two shunt-wound machines are connected together at no load, and no change is made in their field rheostats, then the voltage of both machines will decrease with increase of load, and the two machines will divide the load as determined by their voltage regulation.

As an example, consider two 200-kw. generators operating in parallel, having voltage regulations as shown by the curves *A* and *B* in Fig. 1. A total load of 450 kw. will divide as indicated, 200 kw. on generator *B* and 250 kw. on *A*.

There are three adjustments that can be made to change the regulation of shunt-wound generators:

a. The demagnetizing effect of the armature current on the field poles is proportional to the amount of brush shift. The greater the brush shift, therefore, the broader the regulation. Commutation primarily determines the brush position, and it is unwise to sacrifice commutation for regulation.

b. Increasing the air gap improves regulation, while decreasing it has the opposite effect. Most machines are arranged with shims back of the polepieces, and these may be removed or added to, depending on the results desired. Mechanical dimensions determine the minimum air gap, and field copper the maximum. It should be remembered, however, that the design of a machine determines the proper air gap, and any change from this value may result in some slight disadvantage, but usually not sufficient to affect the operation of the machine in any way except regulation.

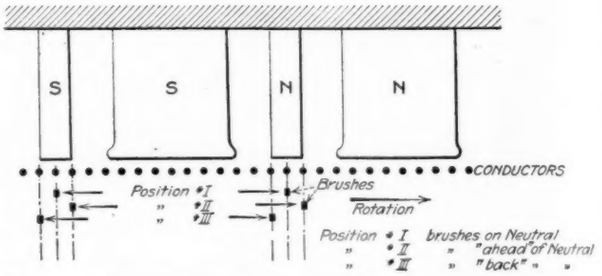


FIG. 2. DIFFERENT BRUSH POSITIONS IN REFERENCE TO THE COMMUTATING POLES

c. A change in speed also affects voltage regulation. Speed changes are to be used only within narrow limits. Better regulation is obtained by lowering the speed or improving speed regulation, or by a combination of the two.

Commutating-pole machines require very careful adjustments if the best results are to be obtained. Connections are shown for a shunt-wound commutating-pole type machine in Fig. 5.

At brush position No. 1 in Fig. 2, the effect of the commutating field is normal with regard to regulation. With the brushes in position No. 2 or 3, a part of the commutating-field flux is not effective for commutation, but combines with the flux of the main pole, subtracting from it with forward and adding to it with backward brush shift.

The voltage generated by a direct-current machine is the sum of the voltages of all coils connected to the commutator bars between positive and negative brush studs. If the brushes were shifted 90 electrical degrees

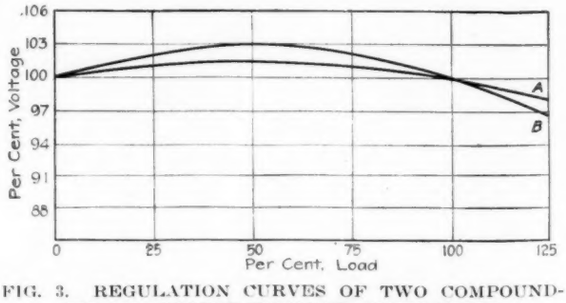


FIG. 3. REGULATION CURVES OF TWO COMPOUND-WOUND, DIRECT-CURRENT GENERATORS

from the neutral position, no voltage would exist between positive and negative studs. Similarly, if the brushes were shifted a few degrees as in position No. 2, Fig. 2, in this position some of the conductors connected to commutator bars between the studs would cut the flux from the commutating field; and since this flux is proportional to the load, the voltage characteristic with forward brush shift is similar to that of a differen-

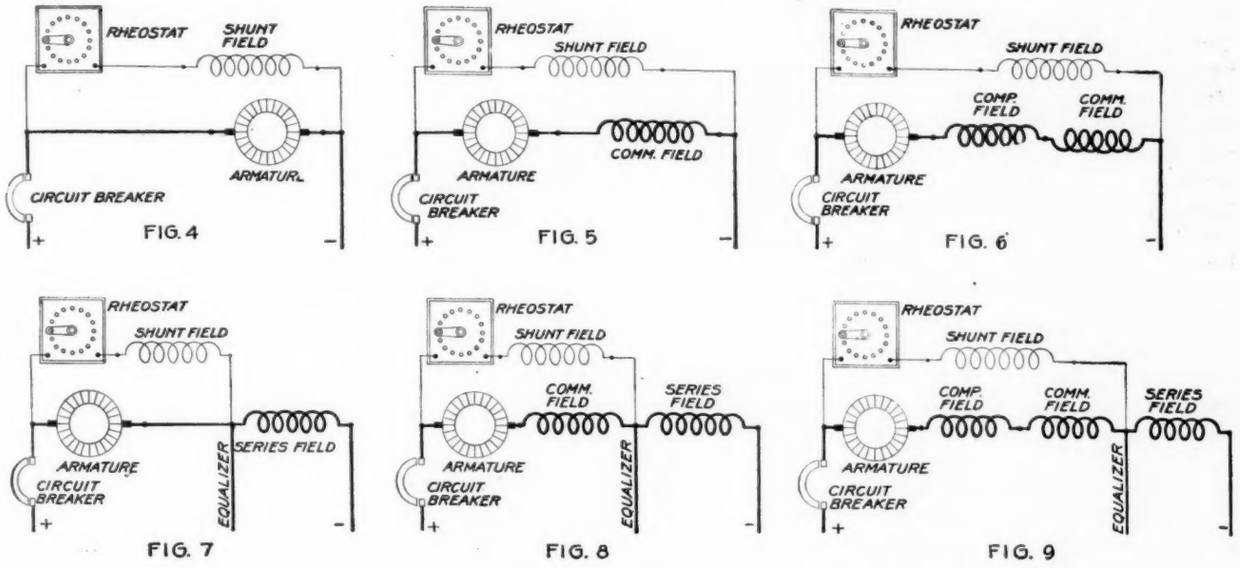
tially wound generator. Backward brush shift is a compounding effect. Brush position and commutating-field strength are definitely related, a backward of neutral position requiring a stronger, and ahead of the neutral a weaker flux. If the brush position is changed, the strength of the commutating machine should usually be changed. This, however, depends on the correctness of the original adjustment. The effect of air gaps, speed and speed regulation, are the same as in the non-commutating-pole type.

An equalizer is used in connection with shunt-wound commutating-pole machines in some instances. Such an arrangement becomes necessary only where the voltage regulation is made very close owing to the compounding effect of the commutating field. The equalizer functions here as in compound-wound machines. An equalizer is undesirable on shunt-wound, commutating-pole machines, since for the equalizer to function, the commutating-pole field strength is necessarily changed from its correct value.

sistance is often connected in the line cables for obtaining a proper balance. Resistance should never be connected in the equalizer cable. If the resistances of the field circuit are not properly balanced. the machine with the low-resistance field circuit will take more than its proportion of the load.

The compounding curves of generators vary greatly, and except for the correcting effect of the equalizer, generators with voltage characteristics as shown in Fig. 3 would not divide a load properly between them at any point except zero and 100 per cent. The amount of compounding above a given no-load voltage may be varied by changing the strength of the compound winding, raising or lowering the speed, changing the speed regulation, shifting the brushes, or changing the air gap.

Connections for a compound-wound commutating-pole generator is given in Fig. 8 and the connection for a compound-wound commutating-pole compensated machine is given in Fig. 9. In adjusting these types for



FIGS. 4 TO 9. DIAGRAMMATIC CONNECTIONS FOR VARIOUS TYPES OF GENERATORS

The shunt-wound, compensated, commutating-pole generator is very similar to the commutating-pole type except that, instead of neutralizing the armature reaction only under the commutating pole, it is more or less entirely neutralized by the compensating windings, depending on the amount of compensation. The connection for this type of machine is given diagrammatically in Fig. 6. The effects of brush position, strength of field, etc., are the same as in the commutating-pole type.

To obtain stability in parallel operation of compound-wound noncommutating-pole generators, they must be connected together at points where a drooping-voltage characteristic results with increase of load. The equalizer connection, if made on the armature side of the compound-field winding, will accomplish this result (see Fig. 7).

The compound-field windings with their connecting line cables of all machines in parallel are in multiples between the equalizer and the bus, and it is therefore important that the resistance of these circuits be inversely proportional to the rating of the machines. Re-

parallel operation, the fact that the series field does not necessarily produce all the compounding should be kept in mind. The actual compounding depends on the strength of the compound field, the brush position and the strength of the commutating field. Parallel operation is sometimes difficult even though the voltage characteristic of each generator is approximately the same. The real difficulty lies in the fact that while each machine has the same regulation at the line terminals, each does not have the same regulation at the point of equalization, and the machines may compound entirely from the action of the compound field, while another may compound but slightly from this source, but from the commutating field and brush position. The equalizer cannot be very effective in such cases, since all equalizing must be done by current changes in the compounding-field winding, and if any such field has little or no effect on the compounding, it follows that the equalizer has little effect on the division of load among the machines. The equalizer cable of any machine should be designed to carry not less than 50 per cent. full-load current.

Operating Cost, Tamarack Mills Power Plant

Analyses of cost of operation of the Jenckes Spinning Co. and the Tamarack Mills power plant.

IN *POWER* for Mar. 26 appeared an article setting forth the chief features of the new Tamarack Mills power plant, Pawtucket, R. I. This plant and that of the Jenckes Spinning Co. near-by are two of the most interesting in New England, particularly in the textile industry. At the time the article referred to was written, operating-cost figures were not available; but they are given in the following. As pointed out in the article, both the Tamarack plant and that of the Jenckes Spinning Co. burn fuel oil exclusively in B. & W. water-tube boilers. The former is a high-pressure turbine plant, the latter a reciprocating-engine mixed-pressure turbine plant; both use atmospheric cooling towers for cooling the condensing water.

This is a good time to call the reader's attention to an error in the price of oil for the Tamarack plant, as stated in the article in *Power* for Mar. 26. It was given as 92c. per bbl. of 42 gal. The price paid is $1.15 instead; 92c. per bbl. is the old contract price made about two years ago for the Jenckes Spinning Co.'s plant.

There follows a brief analysis of the cost per kilowatt-hour of generating power in the Jenckes Spinning Co.'s power station and in the Tamarack No. 2 power station. The figures given are actual operating expenses incurred during one week's continuous run. The matter of oil, repairs, supplies, etc., was estimated and then verified by reference to the accountant's books, so that the total over-all cost per kilowatt-hour includes every expense that can rightfully be charged against the operating expenses.

With particular reference to the fixed charges on these two power stations, it is believed that the following figures will serve as an accurate criterion in estimating the gross costs of power delivered to the switchboard. The percentages given are those that are normally used in plants of the capacity, and containing like generating equipment.

Fixed annual charges: Interest, $0.06000; depreciation (annuity basis), $0.03344; taxes (¾ of total cost at 1½ per cent.), $0.01125; insurance, $0.01000; total fixed charges, $0.11469.

The item of depreciation given as 3.344 per cent. is figured on the annuity basis, which is the common practice in plants of this nature. The percentage of the total costs of the plants must be set aside at the beginning of each year, for a period of 17 years (the estimated average life of the complete plants), the same assumed to earn interest during the whole period at the rate of 6 per cent. compounded.

Using the figures given of 11.46 per cent. as the average annual fixed charge on the two plants, the gross cost of power delivered at the switchboards, per kilowatt-hour is as follows: Jenckes Spinning Co., $0.00806; Tamarack No. 2, $0.00782.

Note that there is a difference in the gross cost per kilowatt-hour in favor of the Tamarack plant of $0.00024. This decrease is due to the fact that the items of repairs, supplies, lubricating oil and labor cost 27 per cent. less in the Tamarack plant than in the Jenckes Spinning plant. If, on the contrary, the costs on the two plants were identical, the total net cost per kilowatt-hour in the Jenckes Spinning plant would be somewhat less than in the Tamarack plant, due to the fact that fuel oil costs approximately 28 per cent. less in the Jenckes Spinning Co.'s plant than in the Tamarack plant.

ECONOMY CALCULATIONS OF THE JENCKES SPINNING CO.'S POWER PLANT FOR WEEK ENDING FEB. 23, 1918:

The engine room of this plant contains the following equipment:
One Harris simple engine, 30½ x 60-in., 66 r.p.m.
One Harris simple engine, 24⅝ x 48 in., 76 r.p.m.
One 1,000-kw. mixed-pressure turbine, taking exhaust from engines and auxiliaries, in excess of amount required to heat feed water.
One 300-kw. noncondensing turbine, the exhaust steam from which is used for heating feed water and operating 1,000-kw. unit.
One 390-hp. synchronous motor belted to the engines and connected in parallel with the turbines, this motor being allowed to float on the line, sometimes operating as a generator and again as a motor.

A. Total Quantities:

1.	Kind of fuel	Mexican fuel oil
2.	Total oil used at 147 deg. F., bbl	1657.3
3.	Total oil used at 147 deg. F., gal	69,606.6
4.	Weight of one gallon oil as fired, lb	7.7
5.	Total weight of oil, lb	535,970.8
6.	Total water feed to boilers, gal	710,600
7.	Total weight of water, lb	5,921,667
8.	Total water evaporated, corrected for quality of steam (0.985 estimated), lb	5,840,000

B. Economy:

1.	Water fed per pound of oil as fired, lb	11.10
2.	Water evaporated per pound of dry oil (estimated), lb	11.14

C. Cost of Evaporation:

1.	Cost of oil per barrel of 42 gal., cents	0.90
2.	Weight of gallon of oil at 60 deg., lb	8.02
3.	Cost of oil per pound, delivered to tanks, cents	0.267
4.	Cost of oil per one thousand pounds of water evaporated, cents	24.05
5.	Cost of 1,000 lb. of water (8c. per 1,000 gal.), cents	0.96

D. Chargeable to Power:

1.	Fuel oil (estimated), bbl	1,325.9
2.	Total cost fuel oil, dollars	1,193.31
3.	Water purchased, gal	568.48
4.	Total cost water, dollars	45.48
5.	Labor, dollars	193.00
6.	Oil, dollars	10.00
7.	Repairs, dollars	72.12
8.	Supplies, dollars	7.80

E. Chargeable to Heating:

1.	Fuel oil (estimated), bbl	331.4
2.	Total cost fuel oil, dollars	298.26
3.	Water purchased (estimated), gal	142.12
4.	Total cost water (8c. per 1,000 gal.)	11.37
5.	Labor all charged to power	
6.	Repairs (estimated), dollars	25.00
7.	Total weekly heating costs, dollars	334.37

F. Power-Plant Details:

1.	Total average output for 54 hours (nights), hp	2,436.7
2.	Total average output for 54 hours (days), hp	2,829.0
3.	Total grand average (54 hours), hp	5,265.7
4.	*Total kw.-hr. generated	213,800
5.	Load factor of plant, per cent	64.2
6.	Pounds of steam per kw.-hr	21.8
7.	Pounds of oil per kw.-hr	2.09
8.	B.t.u. per pound of oil (estimated)	18,400
9.	Over-all efficiency of plant, per cent	8.9

G. Unit Costs of Power per Kilowatt-Hour, Dollars:

1.	Fuel oil	0.005600
2.	Water	0.000230
3.	Labor	0.000965
4.	Oil	0.000047
5.	Repairs	0.000338
6.	Supplies	0.0000365
	Total cost per kilowatt-hour	0.0072165

NOTE.—No allowance made for overhead charges which should be added to "G" to give gross costs.

*The figure of 213,800 kw.-hr. is the net power output after deductions for excitation and other auxiliaries.

ECONOMY CALCULATIONS OF THE TAMARACK CO.'S NO. 2 POWER PLANT FOR WEEK ENDING MAR. 2, 1918

The engine room of this plant contains the following equipment:
One 2,500-kw. bleeder-type turbine.

A. Total Quantities:

1.	Kind of fuel	Mexican fuel oil
2.	Total oil used at 149 deg. F., bbl	1,227.8
3.	Total oil used at 149 deg. F., gal	51,567.6
4.	Weight of one gal. of oil as fired (estimated), lb	7.7
5.	Total weight of oil, lb	397,070.5
6.	Total weight fed to boilers, gal	594,510
7.	Total weight of water, lb	4,954,250
8.	Total water evaporated, corrected for quality of steam 0.985 (estimated), lb	4,870,000

B. Economy:	
1. Water fed per pound of oil as fired, lb	12.05
2. Water evaporated per pound of dry oil (estimated), lb	12.54
C. Cost of Evaporation:	
1. Cost of oil per barrel of 42 gal., dollars	1.15
2. Weight of gal. of oil at 60 deg. F. (estimated), lb	8.02
3. Cost of oil per pound, delivered to tanks, cents	0.342
4. Cost of oil per 1,000 lb. of water evaporated, cents	27.4
5. Cost of 1,000 lb. of water (8c. per 1,000 gal.), cents	0.96
D. Chargeable to Power:	
1. Fuel oil (estimated), bbl	1,050
2. Total cost fuel oil, dollars	1,207.50
3. Water purchased, gal	510,000
4. Total cost water (8c. per 1,000 gal.), dollars	40.80
5. Labor, dollars	153.00
6. Oil, dollars	5.00
7. Repairs (estimated), dollars	50.00
8. Supplies, dollars	6.00
E. Chargeable to Heating:	
1. Fuel oil (estimated), bbl	177.8
2. Total cost fuel oil, dollars	204.47
3. Water purchased (estimated), gal	84,510
4. Total cost water (8c. per 1,000 gal.), dollars	6.76
5. Labor (all charged against power)	
6. Repairs (estimated), dollars	15.00
7. Total weekly heating costs, dollars	226.23
F. Power-Plant Details:	
1. *Total kw.-hr. generated	208,100
2. Load factor of plant, per cent	49.5
3. Pounds of steam per kw.-hr	20.4
4. Pounds oil per kw.-hr	1.69
5. B.t.u. per pound oil (estimated)	18,400
6. Over-all efficiency of plant, per cent	10.9
G. Unit Costs of Power per Kilowatt-Hour, Dollars:	
1. Fuel oil	0.005790
2. Water	0.000196
3. Labor	0.000736
4. Oil	0.000024
5. Repairs	0.000240
6. Supplies	0.000029
Total cost per kilowatt-hour	0.007015

NOTE.—No allowance made for overhead charges, such as interest, insurance, depreciation, etc., which should be added to "G" to give gross costs.

* F-1: The figure of 208,100 kw.-hr. is the net power output, after deductions for excitation and other auxiliaries.

The foregoing data were obtained through the courtesy of Charles E. Teft, chief engineer of both plants and of Robert L. Brunet, Public Service Engineer for the city of Providence, R. I., who is consulting engineer for the Jenckes Spinning Co.

Electric Current Without Cost During Heating Season

An instance of the saving to be realized by generating the necessary current in a building where heat is maintained is found in the New Weston Hotel on the northeast corner of Madison Ave. and 49th St., New York City. Although the generator has been in operation only a short time, the showing at present is that the electric current used for light and elevator service is a cost-free byproduct and will continue so during the heating season at least. Mr. Clayton, the lessee of the building and proprietor of the hotel, feels that with his modern kitchen equipment he will be able to utilize a large percentage, if not all, of the exhaust steam in summer also, because of the diminished use of current for lighting during that period. The new unit is a high-speed self-contained American Ball 50-kw. three-wire direct-current set with an automatic oiling system, so that operating attention is reduced to a minimum. Another unit of the same type but only about 25 kw. capacity will be put in as soon as the manufacturers can deliver it. This small unit will be able to supply the current during the periods of least demand—during the day and the late part of the night. The chief engineer, James Daugherty, is enthusiastic over the showing already made and expects to do still better when the new set is in, which will permit better manipulation or handling of the load.

The building has a frontage of 79½ ft. on Madison Ave. and 85 ft. on 49th St., is 12 stories high and contains 176 guest rooms besides the commodious dining rooms and offices—roughly, 7000 sq.ft. of floor space. It is of modern fireproof brick and steel construction, so that heating it is not difficult, and by the use of high-efficiency lamps the current consumed is comparatively small, making an ideal combination for a private plant, especially since the services of an engineer are essential and no additional help is required whether the generating units are in use or not. Complete operating costs for a year, when available, will furnish material for comparison with past performance when no current was generated.

Notwithstanding the extremely cold weather and the poor quality of the coal he is able to procure, Mr. Clayton's daily reports show no increased coal consumption, while generating all the electric current used about the hotel for illumination and elevator service, over that used when only the heating was being done, so that the electricity generated can be considered as a byproduct.

The calculation regarding the capital invested and the return from it, is interesting. Placing the cost of the first unit at, say, $2500 (which seems ample considering the fact that there was practically no cost for the foundation, switchboard, etc.), and the annual reduction in the cost of service at $620, the difference between $1100, the approximate total cost per year for the street service and the partial street service still retained at a cost of $480 per year, or $40 per month for the minimum. Six per cent. of $2500 = $150 interest to be deducted from $620, leaving $470 to be deducted from $2500 = $2030 remaining at the end of the first year. Continuing the calculation for succeeding years, it would show $1532 at the end of the second, $1004 at the end of the third and $444 at the end of the fourth, so that by the end of the fifth year this unit would have paid for itself.

Taking again the case of the smaller (second) unit, this should not cost more than $1500 and by means of it the street service could be dispensed with, saving $480 per year. Six per cent. of $1500 = $90, which, subtracted from $480, leaves $390 to be deducted from the first cost at the end of the first year, leaving $1110. There would remain $697 at the end of the second year, $259 at the end of the third, and by the end of the fourth year this unit would be paid for by its own output.

Therefore, allowing liberally for insurance, extra taxes, repairs, lubricants and a proportionate fuel charge for that part of the year when the exhaust steam is not all used, the period required for the installation to pay for itself is not extended more than a year or two at most. Or, extending the period of the transaction to 20 years and allowing for a total depreciation in that time, 5 per cent. of the $4000 investment, or $200, would have to be deducted annually from the net saving shown after overhead is taken care of. Then $4000 at 6 per cent. interest and say 1 per cent. for extra taxes and insurance, 7 per cent. in all, from $1100 is ($4000 at 7 per cent. = $280 + $200 refund on principal) $480, leaving $620 net per year. Even setting aside $120 per year for "incidentals" leaves a $500 saving, or 12½ per cent. clear on the original investment.

Low-Pressure Turbines for Lineshaft Drive

By R. J. HORNE

Geared low-pressure steam turbine used to drive a lineshaft in a paper mill resulted in obtaining 600 hp. without any cost for steam and made it possible to operate the plant with eight boilers in service where before the installation of the turbine thirteen boilers were required.

MANY a mill owner whose plant is driven by lineshafts finds, when he seeks to add power supply, that the simplest solution—electric-motor drive supplied from existing power lines—is not available. Often, however, there is sufficient boiler capacity in the plant to do the work if it is effectively applied. Particularly where the lineshaft drives only a small number of machines, an ingenious solution of the problem is to install a turbine, with reduction gearing.

In a western Pennsylvania paper mill there is a unique lineshaft drive consisting of a Westinghouse low-pressure turbine and double-reduction gear, Fig. 1. There are two mainline shafts to which the machines are belted. To one lineshaft are belted two cutters, ten beaters and one jordan; and identical equipment, with the exception of the cutters, is belted to the other shaft. Under ordinary running conditions only seven of the ten beaters on each shaft are in operation at one time, and these, with one jordan, require about 600 hp. The rag cutters take 20 hp. each.

Originally, these two lineshafts were each driven by a noncondensing reciprocating engine. However, one of these engines was wrecked, and it became necessary to obtain some form of drive to replace it.

It is interesting to note the considerations entering into the final selection of the new drive. These conditions were somewhat as follows: Two 100-hp. noncondensing engines turned the rolls and gave practically all the exhaust steam necessary for feed-water heating, so that all the exhaust steam from the 700-hp. noncondensing Corliss engine driving one of the lineshafts would have to be discharged to the atmosphere unless some means were provided for abstracting the energy still available in it. A low-pressure turbine was, without a doubt, the logical prime mover, but it would have been of little use, on account of its high speed, without suitable reduction gearing.

Other types of drive were considered, but each had inherent characteristics which disqualified it; for instance, a duplication of the old reciprocating engine with the inevitable wasting of exhaust steam. A condensing engine would have been expensive and no material improvement. Again, an electric motor, while comparatively cheap to install, would have been much more expensive when the electric-power bill was added to the cost of energy lost in wasted exhaust steam. And finally, it was still more expensive to install a turbine generator and an individual electric drive, because the existing equipment was of an entirely different character. In a new plant where all equipment is being installed for the first time, the individual electric drive is by far the best, for reasons too well known to need discussion here.

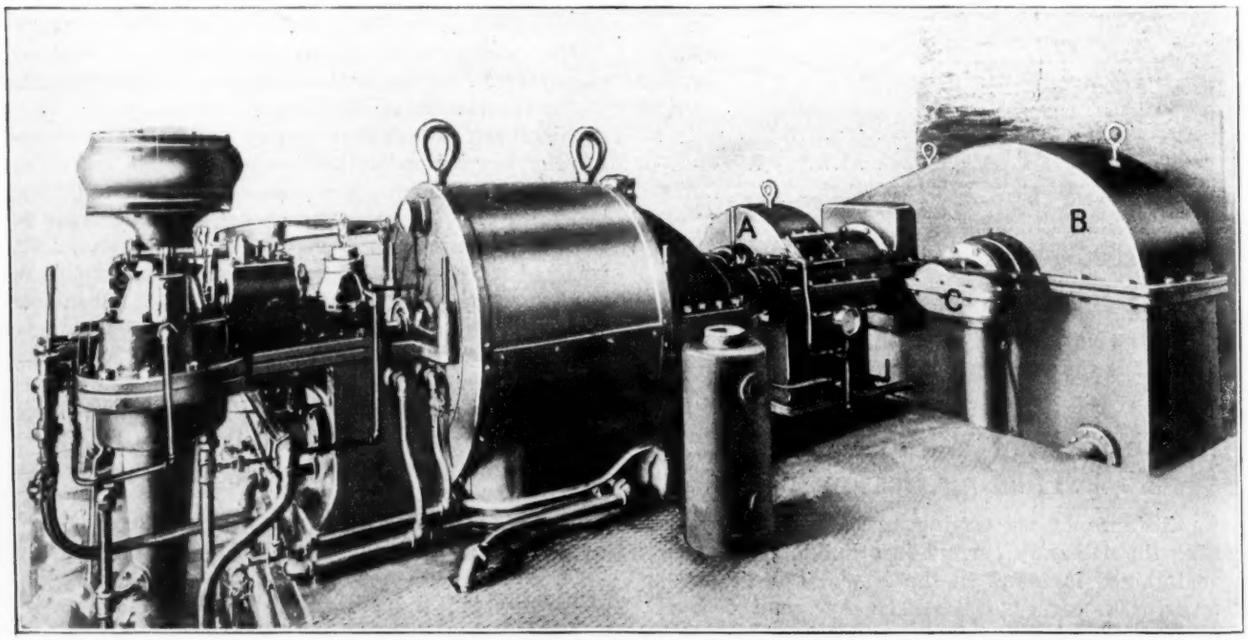


FIG. 1. LOW-PRESSURE STEAM TURBINE WITH DOUBLE-REDUCTION GEARS

A few approximate figures will show more clearly the fitness of the low-pressure turbine for this application. The exhaust steam from the 700-hp. Corliss engine was more than sufficient to give 600 hp. in the low-pressure turbine. The engine takes steam at 150-lb. pressure and exhausts into an oil separator at a back pressure, depending on the load, from 0 to 4 or 6 lb., which is approximately the pressure of admis-

sion to the low-pressure turbine. The steam is then expanded in the turbine down to a vacuum corresponding to 27.5 in. of mercury referred to a 30-in. barometer, the vacuum being maintained by a Westinghouse-Leblanc low-level jet condenser and air pump. The pumps are centrifugal and are driven by a small steam turbine through a reduction gear. They take their water from a near-by creek and discharge it from the condenser into a reservoir at an elevation of 45 ft. This water is used in the manufacturing processes. The small turbine runs noncondensing, and its exhaust steam goes to the feed-water heater, so that only a part of the heat energy in the steam used by it can be charged to the turbine, and even that cannot be charged against the main turbine, for it is used to do work in elevating the discharge water from the condenser to the reservoir and should be charged against the total cost of manufacturing. In brief, it may be said that this paper company actually gets 600 hp. without paying a cent for steam and is using just one-half the steam formerly used with two reciprocating engines for the same power.

While this particular mill was not enlarged, it is evident that with a given amount of exhaust steam, either for noncondensing engines or condensing engines run noncondensing, a large increase of power is made available by the installation of a low-pressure turbine. Further evidence of this possibility for expansion is the fact that, in this paper mill, when the two lineshafts were driven by noncondensing reciprocating engines, a battery of 13 boilers was required, whereas now only eight are required for the maximum load.

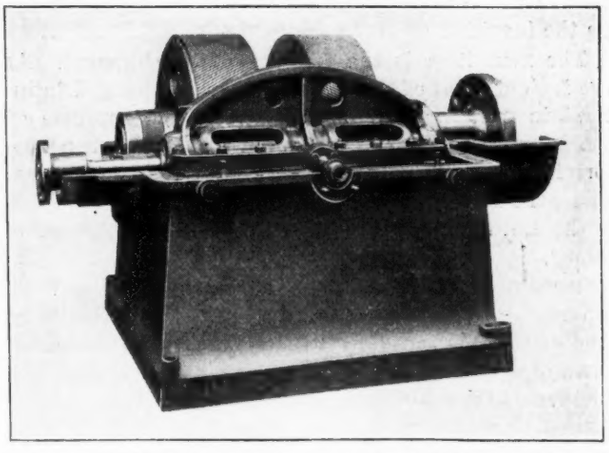


FIG. 2. FLEXIBLE-FRAME GEAR WITH COVER REMOVED

Although the application of the low-pressure turbine is an interesting one, the means of transmitting its high-speed power to a slow-speed lineshaft is fully as interesting and as important. The change in speed is made by means of two reduction gears, shown at *A* and *B*, Fig. 1, because the first cost of a single gear and pinion of ratio 36 to 1 would be prohibitive and the gear would be very large and unwieldly. The first speed reduction, 3600 to 720 r.p.m., is made with a fixed bearing type of reduction gear, the gear shaft of which is direct-connected to the pinion shaft of the second gear, which reduces the speed from 720 to 103 r.p.m.

This larger reduction gear is of the flexible-pinion frame type, known as the Westinghouse I-beam type. In this the pinion is supported on three bearings in a frame, as shown in Figs. 2 and 3. This frame is supported under the middle bearing on an I-beam at right angles to the pinion axle. The flexibility of the web of this I-beam support allows the pinion to tip slightly and to let the teeth of the pinion line up with those of the gear. This lining up is entirely automatic and instantaneous in operation, so that no mechanical complications are encountered and no adjustments from the outside of the gear case are necessary at any time.

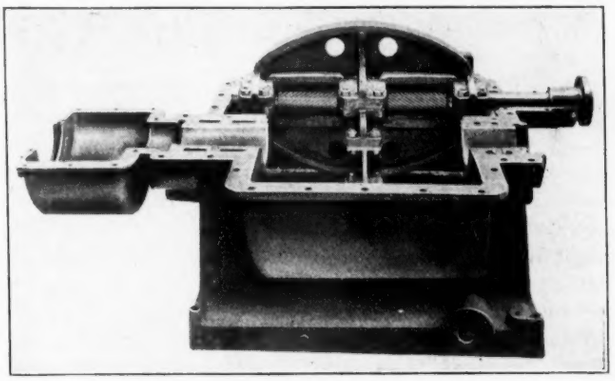


FIG. 3. FLEXIBLE-FRAME GEAR SHOWING HOW THE THREE PINION BEARINGS ARE SUPPORTED

Both reduction gears are lubricated by sprays of oil directed upon the teeth just before they mesh. The oil pressure is maintained by a pump geared to the gear shaft, as shown at *C*, Fig. 1. This pump also supplies oil under pressure to all the bearings in the two reduction gears. For starting, a hand pump is provided which insures a plentiful supply of oil at the bearing and teeth.

It may be asked why a fixed-bearing type of reduction gear was used in one case and an I-beam type in the other. It was a question of tooth pressure which determined the design. Take, for instance, a pinion transmitting 600 hp. at 3600 r.p.m., which was the case of the first reduction gear in the particular installation under discussion. If the same pinion was to turn at 720 r.p.m. and with the same tooth pressure, that is, pounds pressure per inch of tooth face, it would be capable of transmitting one-fifth of 600 hp., or 120 hp., only. It follows, then, that the second gear would have been made five times as large as the first if the same type had been used, and for the transmission of the same amount of power. Such a reduction gear would have been large and bulky. It would also have been costly, because cost is a function of size.

In order, then, to make a reduction gear that would be within reasonable limits as to size, and at the same time marketable, the allowable tooth pressure had to be increased, or in other words, the factor of safety included in the allowable stress in fixed bearing design had to be lowered. But if this were done, some other safety factor would have to be incorporated to insure reliability of operation, otherwise a slight misalignment of the teeth and uneven distribution of tooth pressure would result in a failure of the gear. This safety factor was found in the I-beam support for the pinion, which corrects any misalignment and uneven pressure distribution that might otherwise exist.

In the case of the reduction gear with fixed bearing support for the pinion, misalignment, although prac-

tically prevented by good workmanship, will not have disastrous results if it should exist, because of the high factor of safety used in the tooth design.

The actual efficiency of the two gears together is 97 per cent.; that is, only 3 per cent. of the total power transmitted is lost in them. This energy is dissipated in the form of heat and is taken up by the oil, which in turn is cooled by a water-cooling system. As to reliability, in the paper mill under discussion the double reduction gear has run 24 hours per day, six days per week, under maximum load, and it has never been shut down on account of trouble with the gears.

The Cost of Coal

DURING the first few weeks of this year, when the entire country was in the grip of unusually severe winter weather and the railroads were unable to meet the demands made upon them for the transportation of fuel, the price of coal was a matter of secondary importance. The main consideration was the possibility of getting coal, regardless of kind, grade or size, at any price whatever.

Now that moderate weather has decreased the pressing demand for coal and has allowed the railroads to recover somewhat from their congestion, the coal user naturally turns again to a consideration of the cost of his fuel.

The cost of coal to the consumer is the sum of several items, each of which can be reckoned more or less exactly. The first of these is the price of the coal per ton at the mine. This is fixed by the Government, since a definite schedule of rates is set to cover the selling prices of the various kinds and sizes of coal. These prices, per ton f.o.b. at the mines, are given in Tables I and II. They should be increased by the amounts allowed for wage increases, as given in the footnotes to the tables. Also, the reductions allowed during certain months of the year should be taken into account in all cases in which they are applicable.

Since the issuance of the order putting into effect the reduction of 30c. a ton on anthracite for domestic use, the Interstate Commerce Commission has granted the railroads an increase of 15c. a ton on all coal freighted. As a consequence, coal dealers are puzzled to know whether they shall reduce their price 30c. and pay the increased freight of 15c. or whether they shall reduce the price to the consumer only 15c. The Fuel Administration will be asked to decide the matter.

TABLE I. PRICES OF ANTHRACITE

Arkansas:	Grate	Egg	Stove	No. 4	Pea	Buck.	Slack
Bernice district....	$7.30	$7.55	$8.30	$8.30	$6.30	$2.85	$2.50
Spadra district....	6.80	6.80	....	7.30	4.80	....	2.50

The foregoing prices are f.o.b. mines and nothing to be added.

All these prices—except those for slack—are subject to the following reductions: 90c. in April, 1918; 75c. in May; 60c. in June; 45c. in July; 30c. in August; 15c. in September.

Pennsylvania:	Broken	Egg	Stove	Chestnut	Pea
White ash.....	$4.55	$4.45	$4.70	$4.80	$3.40
Red ash.....	4.75	4.65	4.90	4.90	3.50
Lykens Valley.....	5.00	4.90	5.30	5.30	3.75

The foregoing prices do not include the 35c. per ton allowance for wage increase under the President's order of Dec. 5, 1917.

Beginning Apr. 1, 1918, and continuing to Sept. 1, 1918, the prices on all Pennsylvania anthracite for domestic use are subject to a reduction of 30c. per ton

The first schedule of Government prices, which went into effect less than a year ago, covered only such coal as had not been contracted for, or, in other words, free coal. By the first of April of this year, most contracts will have expired, and any further purchases or contracts to purchase will be made on the basis of the new prices. The prices shown in Tables I and II include all changes and modifications up to the fifth of April, 1918.

Jobbers' commissions as separate items of cost have been eliminated; instead, the commission of the jobber is included in the price at the mine, beginning Apr. 1, so that the retail dealer will obtain coal at the same price, whether purchased through a jobber or direct from the mine.

Still another item of cost that may have to be considered in connection with bituminous coal is the allowance for cleanness. According to a ruling of the Fuel Administration, operators who use special means to eliminate impurities from their products will be allowed to add 20c. a ton to the Government prices for coal at the mine. The objects of this concession are to stimulate production and to insure a better quality of coal. The offer embraces the period from Apr. 1 to July 31, 1918, and permits will be extended beyond Aug. 1 in all cases in which such action seems proper. Retail dealers must also obtain permits from the Fuel Administration before they will be allowed to add to their prices the allowance made to the operators. Specially cleaned coal will be designated by cards in the cars in which such coal is loaded and also by notations on the invoices.

The next item is the freight on the shipment. As the freight rates of the various railroads engaged in interstate transportation are subject to the approval of the Interstate Commerce Commission, they can be determined by addressing an inquiry to the commission. Thus, the freight charge per ton of coal from the mine to the destination of the shipment may readily be ascertained.

In many cases the coal must be transported a part of the way by barges or steamers. This is particularly true of the coal consumed in New York City and many parts of New England. Transportation by water adds another charge for lighterage or water freight. In normal times the water haul from New York to Boston is about 50c. a ton, and from Newport News to New England ports it is from 70 to 90c. a ton; but under the stress of a scarcity of coal-carrying bottoms these charges rose to as much as $4 a ton during the recent fuel crisis.

If the coal is purchased through a local dealer, or if the purchaser must pay for hauling the coal from the wharf or railway to his plant, there will be a charge for delivery. The amount of this item is easily and directly obtainable.

After the several items of cost have been determined or estimated, the reasonable total cost of the coal per ton may be found by adding them. The sum will give the consumer a fair idea of what his coal should cost. If the price he is paying is very greatly in excess of the calculated price, he may feel reasonably certain that someone is profiteering at his expense.

TABLE II. PRICES OF BITUMINOUS COAL PER TON F.O.B. AT THE MINES

State	Run of Mine	Prepared Sizes	Slack or Screenings
Alabama:*			
Big Seam district	$2.15	$2.45	$1.85
Cahaba, Black Creek, Brookwood and Blue Creek districts	2.85	3.10	2.45
Pratt, Jaeger, Jefferson, Nickel Plate and Coal City districts	2.35	2.65	2.05
Corona district	2.40	2.75	2.05
Montevallo district	2.40	4.00	2.15
Coal mined in upper bench of Big Seam	2.35	2.65	2.05
Coal mined at Lynn mines of Monroe Warrior Coal and Coke Co. for use at Macon, Ga.	3.50	4.00	3.10
Coal mined by Cahaba Southern Coal Mining Co., Hargrove, Bibb County	2.85	3.70	2.45
Climax Seam, near Maylene, Shelby County	4.25	4.50	2.15
Arkansas	2.65	2.90	2.40
Johnson, Franklin and Sebastian Counties, except Excelsior district	3.70	4.60	2.40
Logan and Scott Counties and the Excelsior district of Sebastian County	4.35	5.15	2.60
Colorado	2.45	2.70	2.20
Domestic coal, domestic field †	2.25	3.50	1.25
Steam coal, Trinidad district ‡	2.35	3.25	1.65
Lignite coal	2.25	3.25	1.00
Georgia	3.25	3.50	3.20
Illinois:			
Mercer, Bureau, Kankakee, La Salle, Grundy, Will, Putnam, Marshall, Livingston, Woodford, and McLean Counties	2.65	2.90	2.40
Rock Island, Henry, Warren, Knox, Stark, Peoria, Hancock, McDonough, Henderson, Fulton, Tazewell and Schuyler Counties	2.40	2.60	2.10
Menard, Logan, Dewitt, Champaign, Vermilion, Sangamon, Macon, Pratt, Christian, Moultrie, Shelby, Greene, Macoupin and Montgomery Counties, Madison County north of latitude of Alton, and all mines which are not included in other rulings	2.00	2.20	1.70
Bond, St. Clair, Monroe and Randolph Counties and Madison County south of latitude of Alton, and Clinton, Washington and Perry Counties, not including mines along Illinois Central R.R. between Vandalia and Carbondale	2.00	2.20	1.70
Jackson County, not including mines along Illinois Central R.R. between Carbondale and Duquoin	2.40	2.60	2.10
Marion, Jefferson, Franklin, Williamson, Johnson, Hamilton, Saline, White, Gallatin, and mines along main line of Illinois Central between Vandalia and Carbondale in Clinton, Washington, Perry and Jackson Counties	2.00	2.20	1.70
Indiana	1.95	2.20	1.70
Brazil Block field	....	2.95	1.70
Iowa	2.70	2.95	2.45
Appanoose, Wayne, Boone, and Webster Counties	2.75	3.10	2.00
Marion County	2.70	2.95	2.45
Kansas	2.55	2.80	2.30
Osage county	3.05	4.50	2.80
Mines at Leavenworth	3.15	3.40	2.90
Kentucky	1.95	2.20	1.70
Harlan, Perry and Letcher Counties, and operations in Pike County on the Levisa Fork of the Big Sandy River	2.20	2.45	1.95
East of the 85th degree of longitude, except Harlan, Perry and Letcher Counties and operations in Pike County on the Levisa Fork of the Big Sandy River	2.65	2.90	2.40
Maryland	2.40	2.65	2.15
Michigan	3.15	3.60	2.20
What Cheer, Banner, Bliss, Robert Gage, Beaver and Consolidated & Wolverine coal companies	3.40	3.95	2.25
Handy Bros	3.70	4.25	2.55
Caledonia mine	4.55	5.05	3.55
Flint mine		5.55	3.55
Missouri	2.70	2.95	2.45
Lafayette, Ray, Clay, Platte, Linn and Putnam Counties, and Longwall thin seam vein in Randolph County	3.15	3.40	2.90
Montana	2.65	3.30	1.50
New Mexico	2.40	2.65	2.15
Raton district	2.75	3.25	2.00
Sugarite and Monero field	3.00	4.00	2.00
Gallup field	3.05	4.50	2.00
Cerillos and Carthage fields	4.05	5.05	3.55
North Dakota (lignite):			
Run-of-mine	....	....	2.25
Screenings	....	....	1.25
Screened lump	....	....	2.50
6-in. steam lump	....	....	2.00
Ohio:			
Thick vein	2.00	2.25	1.75
Thin vein	2.35	2.60	2.10
Deerfield, Palmyra, Massillon and Jackson fields	3.25	3.50	3.00
Jefferson, Harrison, Belmont, Carroll and Monroe Counties	2.00	2.25	1.75
Oklahoma	3.05	3.30	2.80
Leflore, Haskell, Okmulgee, Tulsa, Rogers, and Coal Counties and the Hartshorn-Wilburton vein in Pittsburg and Latimer Counties	3.70	4.60	2.50
McAlester vein in Pittsburg and Latimer Counties	4.25	5.10	3.00
Pennsylvania	2.00	2.25	1.75
Operations in Tioga, Lycoming, Clinton, Center, Huntingdon, Bedford, Cameron, Elk, Clearfield, Cambria, Blair, Somerset, Jefferson, Indiana, Clarion, Armstrong, Butler, Mercer, Lawrence and Beaver Counties, and in Allegheny County from Lower End of Tarentum Borough north to county line, and in Westmoreland County from point opposite lower end of Tarentum Borough north along Allegheny River to Kiskiminitas River and along Kiskiminitas River eastward to Conemaugh River and along Conemaugh River to Cambria County line, and operations on B. & O. R.R., from Somerset County line to and including Indian Creek and Indian Creek Valley branch of B. & O. R.R.	2.60	2.60	
Pittsburgh field, including counties of Washington, Green, Fayette, Westmoreland and Allegheny, except (1) that portion of Allegheny County from lower end of Tarentum Borough north to county line; (2) territory in Westmoreland County from a point opposite lower end of Tarentum Borough north along Allegheny River to Kiskiminitas River and along Kiskiminitas River eastward to Conemaugh River, continuing along Conemaugh River to county line of Cambria County; (3) operations on Indian Creek in Westmoreland County; (4) operations in the Ohio Pyle district of Fayette County	2.00	2.25	1.75
Ajax Hocking Coal Co., Clearfield and Somerset Counties	2.75	....	....
Tennessee:			
All except Overton and Fentress Counties	2.65	2.90	2.40
Overton and Fentress Counties	2.20	2.45	1.95
Texas	2.65	2.90	2.40
Operators at Thurber and Strawn	3.60	4.40	2.25
Operators at Bridgeport	4.25	5.05	2.25
Young, Erath, and Palo Pinto Counties	3.60	4.40	2.25
Wise County	4.25	5.05	2.25
Lignite run of mine	....	....	1.40
Lignite, screened, with at least 15 per cent. of screenings taken out	....	....	1.50
Lignite screenings	....	....	0.85
Utah	2.65	3.30	1.50
Virginia	2.00	2.25	1.75
Lee, Wise and Dickenson Counties, and Russell County west of Finney on the Norfolk & Western Ry	2.20	2.45	1.95
Washington (Screened Coals):			
Kittitas County	3.55	3.95	2.50
Kittitas County, special steam and gas	....	3.25	....
Lewis and Thurston Counties, sub-bituminous	2.75	....	1.25
Lump	....	3.95	....
Lump nut	....	3.25	....
Nut	....	3.00	....
Washington (Washed Coals):			
Kittitas County	....	4.00	....
Pierce, King, Lewis and Skagit Counties	....	....	2.50
Lump nut	....	6.00	....
Mixed steam	....	5.25	....
Straight steam and gas	....	4.80	....
King County, sub-bituminous	....	....	1.50
Lump nut	....	5.00	....
Pea	....	3.50	....
Buckwheat	....	3.25	....
Lewis County, sub-bituminous	....	....	1.25
Lump	....	3.95	....
Nut	....	3.75	....
Pea	....	3.00	....
Buckwheat	....	1.50	....
West Virginia	2.00	2.25	1.75
Pittsburgh seam in Hancock, Brooke, Ohio, and Marshall Counties	2.00	2.25	1.75
Kenova and Thacker fields and Preston County	2.40	2.65	2.15
Tug River district, coal mining operations on Norfolk & Western Ry., west of Welch to Panther, including branches, except Newhall, Berwind, Canebrake and Hartwell	2.40	2.65	2.15
Pomeroy field	2.35	2.60	2.10
New River	2.15	2.40	1.90
Davy-Pocahontas Coal Co. in McDowell County	2.75	....	....
Ajax Hocking Coal Co. in Mineral County	2.75	....	....
Wyoming	2.65	3.30	1.50

The foregoing prices are f.o.b. mines basis for ton of 2,000 lb. and do not include the 45c. per ton allowed in President's order of Oct. 27, 1917.

* Increase of 45c. per ton does not apply to these mines.

† Prepared sizes subject to following monthly reductions in price: Apr. 1, 70c.; May 1, 50c.; June 1, 35c.; July 1, 15c.; base price again effective Aug. 1.

‡ Prepared sizes subject to following monthly reductions in price: Apr. 1, 40c.; May 1, 30c.; June 1, 20c.; July 1, 10c.; base price again effective Aug. 1.

Fall and Rise of Government Bonds on Account of War

GOVERNMENT bonds, like people, act pretty much like one another under similar conditions. Whether they are French, English, German, Russian, Japanese, American or any other nationality, people will act according to well-established psychological traits, laughing at about the same thing, crying over similar events and manifesting fear under given situations. Corresponding to human temperament, the market value of Government bonds is also subject to well-defined changes, and one of the most consistent similarities of conduct which history shows to be true of them is their habit of temporarily dropping on account of war.

Sometimes they do so to an alarming extent, no matter how stable the government that issued them, no matter how rosy its military situation and no matter how unimpaired the resources behind the securities may be, guaranteeing the prompt payment of their interest and their redemption for full face value at maturity.

But just as consistently as history shows that government bonds go down during the war, no less does it record that their usual habit has been not only to recover to their original price, but also, in many instances, to rise to a marked degree above it after the end of the war.

At the present writing your Liberty Bonds are quoted in the market at about 97. Taken as a detached condition, without regard to history, and looked at simply from the narrow pocketbook point of view, the fact that something you paid $100 for a short time ago will bring you only about $97 at the present moment may seem to be disquieting. But it simply means that United States bonds are now doing what the bonds of all nations do in war time.

Our bonds have depreciated to a lesser degree than most government bonds have done under similar circumstances. One instance may be cited where the bonds of a foreign government went down to almost 50 during a war, but although that nation suffered a crushing defeat and tremendous material losses, within a comparatively few years after the war was ended those same bonds went up to more than 105.

The fact that your $100 Liberty Bond is now selling for about $97 does not in any sense imply a loss of intrinsic value nor uncertainty either as to its principal or interest. It merely implies that because of a complexity of economic factors your Government bond is normally following the way of its historic fellows. Even though Liberty Bonds have thus fluctuated to prices below par, there has been absolutely no fluctuation in the fact that the Government will go on paying the promised interest on them without delay as it falls due, nor in the fact that when the time comes it will redeem them at the full face value regardless of the ups and downs in the market quotations meanwhile.

These ups and downs in the market quotations of government bonds during wars are, in the history of nations, analogous to what the rise and fall of the thermometer is to the weather. Just as you can tell the changes in the temperature by watching the fluctuations in the height of the column of mercury, an expert in finance could almost tell the changes of a country from peace to war merely by looking at the fluctuations in the column of government-bond quotations year by year. He could make a pretty fair guess that the country was at war when bond prices suddenly dropped and fluctuated below the prices of previous years, and then in after years returned to their former levels or higher.

Take the case of Great Britain. Her national debt is funded in the consolidated annuities, or bonds, popularly known as "consols." In 1792 these consols were quoted at 97, but during the Napoleonic wars, 1793-1815, they dropped down to as low as 47¼ in 1798. These consols have fluctuated with England's periods of peace and of war until in 1896 they were quoted at 114. The effect of the present war is shown in the downward quotations of these consols. In 1915 the highest point was 76½ and the low was down to 54, while in 1916 the high was 62¼ and the low 50. In 1917 the high was 56⅜ and the low 51.

The history of the French government bonds, or rentes, shows similar fluctuations on their part. During the Revolution the 5's rentes dropped to 50, and the 3's to 32½. As a result of the Franco-Prussian War, 1870-71, the 3's rentes dropped to 50.35. Although France was defeated, losing Alsace-Lorraine and having to pay a billion-dollar indemnity to Germany, and although there were two funding operations reducing the interest rate, nevertheless the price of France's bonds continued to rise until in 1897 they reached their maximum of 105.25. The present war, true to precedent, has again sent them plunging downward. In 1916 the high was 58 and the low 52.5, and in 1917 the range was 55.5 to 73.25.

Prussian bonds have also felt the full effect of the present war. In 1914 Prussian 4's recorded a high of 86 and a low of 81. In 1915 the high was 65¼, the low 52¾, and in 1916 the high was 58⅛ and the low 50¼.

The United States 4's of 1925, while not showing a very marked decline during the Spanish War, did show a notable rise the year afterward. Their range for 1897 was from a low of 120⅛ to a high of 129½. The year of the war the low price sank to 117¾ and the high during the war period was only 128½. But in 1899 they rebounded sharply, the high for that year being 134½ and the low 128.

Therefore, in their present market quotations below par, United States Liberty Bonds are simply following the trait of their kind as they normally might be expected to do. By the same token, after the war is over, there is no reason to expect otherwise than that they will return to par and then go above par. More than this, in their present comparatively slight depreciation they are showing typical American stability. Instead of falling only two or three points below par, they might have dropped ten or fifteen points without exhibiting a fluctuation as violent as has been shown by the bonds of other less wealthy nations which have finally soared many points above par.

Editorials

Forestalling a Fuel Famine

THE proper period for laying in a supply of coal for the coming winter is the six months now beginning. There is nothing ludicrous in the statement, even though the country stands on the threshold of warm weather. If any individuals are stirred to mirth at the mention of coal and midsummer in the same breath, it is proof that they have failed to profit by the bitter experiences of the winter that is past.

The crisis that gripped the country during the early part of the year was due, in a large measure, to a failure to exercise ordinary prudence and foresight. The country had become so accustomed to living in a hand-to-mouth fashion that this came to be the accepted mode of existence. But the effect of increased fuel consumption due to the war industries had not been taken into account. As a result, the means of supply and distribution that were satisfactory in normal times utterly broke down under the double burden.

Among the many lessons of importance that the war has taught, none is of more consequence than that of our fuel distribution, which touches at the same time the physical comfort and the commercial prosperity of the nation. It has been demonstrated that we cannot wait until the demand has arisen and then expect it to be met instantly. That plan proved a dismal failure.

As a people, we are beginning to extend our vision beyond the tip of our nose, and the range is lengthening rapidly in the light of swiftly moving events. Obviously, the way to avoid a repetition of fuel famine is to accumulate supplies of fuel sufficient to meet necessary requirements at or near the points where they will be needed.

This should be done now, without delay. The placing of orders at this time, with delivery during the summer, will keep the mines working at full capacity, which is highly important. Recent weekly reports have shown alarming drops in coal output, the decrease in some cases being as much as half a million tons. The country needs a definite amount of coal each year, and if the production falls off at one season it must be made up at another; but unfortunately, it may not be possible to speed up production just when the increased demand arises.

Another phase of the matter should be kept in mind. The living expenses of the mine workers go on whether the mines are working or idle. If the orders on hand necessitate continuous operation, the miner can be kept at his job. But if there is a prospect of weeks of part-time work, the miner is going to seek some other kind of labor in which he can earn a steadier—and probably a larger—income. He cannot be blamed if he does. But if the labor at the mines is diverted to other channels, no wiseacre is needed to point out the predicament of the country when the cold weather arrives.

Further than this, the railroads are now in position to deal effectively with the transportation of the coal supply, if it is distributed over the entire summer. The zone system put into effect by the Fuel Administration will reduce the average length of trip, cut out cross-hauling and simplify the whole problem considerably. But all these efforts for the common good will be completely nullified if the public puts off ordering its coal until the first chill winds of October begin to blow. In that direction lies disaster.

Put in your order at once. You need not be perturbed over the thought that you will be accused of hoarding. The Fuel Administration has seen to that. You will be allowed to accumulate all the coal required to meet your normal needs, and no more.

Protect yourself against future discomforts and perform a patriotic service at one and the same time.

Remember the first few weeks of last January.

Put in your coal orders—NOW!

Internal-Combustion Economy

A PRIME condition of high economy in any heat engine is the avoidance of heat waste. This is so obvious in steam-engine practice that it needs no comment, but it is doubtful if, outside of the field of vision of the designing engineer, it is so well recognized in connection with internal-combustion engines. Briefly, all the potential heat of the fuel that is not transformed into work given off at the shaft is wasted. While much of this waste is inevitable, some of it can be avoided. To grasp fully the significance of this factor we should know in just what way heat is wasted. Heat not transformed into mechanical power passes away in the cooling water, in the exhaust and in friction and radiation. The friction of the piston and the bearings passes off in two directions—by direct radiation from the bearings principally, from the piston by conduction through the walls of the cylinder and to some extent by radiation from the interior.

The internal-combustion engineer regards the operation of the engine in two ways—one from the viewpoint of indicated work on the piston and the other from the viewpoint of power delivered to the flywheel. From the viewpoint of indicated work we have the heat of the engine divided into three principal parts—work, jacket loss and exhaust loss. Roughly, the division for the average engine is about even, or one-third to each. Taking the average of tests of gas engines ranging from six to sixty horsepower, the heat distribution runs thirty-eight and three-tenths per cent. in the exhaust gases, twenty-seven and four-tenths per cent. in cooling water and radiation, and thirty-four and three-tenths per cent. indicated work.

The average mechanical efficiency of this same group of engines is about eighty-five per cent. This summary of heat losses gives a goal that the operator should strive to reach or surpass. Both exhaust and jacket losses may be increased by poor adjustment of valves or ignition

or other derangement of the function of the cycle. Jacket loss is increased by keeping the jacket cooler than necessary. Excessive friction is a source of loss that should not be tolerated in any well-conducted engine room.

For a Diesel engine the average heat distribution is: Exhaust gases, twenty-three per cent.; cooling water and radiation, thirty-four per cent.; and indicated work, forty-three per cent.

The average mechanical efficiency of the Diesel is seventy-eight per cent. The high friction loss as compared to that of the gas engine is due to the auxiliaries and especially the air compressor for injection. It is interesting to notice that the final efficiencies of the Diesel and a good gas engine of moderately large power are very closely equal. The efficiency, based on the brake-horsepower, of the Diesel seldom exceeds thirty-five per cent., while gas engines of moderate size have shown total efficiencies of thirty-two and five-tenths per cent.

The value of this knowledge to the operator will be appreciated when he realizes the fact that the efficiency of the engine depends upon keeping it in the very best of operating condition at all times. Excess of friction, improper cooling or any derangement of the valve or ignition mechanism is shown promptly in an increased fuel consumption.

Consideration of heat wastes shows the engine designer opportunities for improvement. One of the most promising fields of endeavor appears to be along the line of cutting down the exhaust waste. The method that gives the greatest assurance of improvement is complete expansion. It has been attempted, but there is one serious stumbling block in its path, and that is friction. It is an easy matter to increase the indicated efficiency by expanding beyond the pressure at which the exhaust is released ordinarily; but to offset that gain, there is the increased friction of the engine, which is likely to equal, if it does not exceed, the gain obtained by increased expansion.

Help the Counter-Offensive by Buying Liberty Bonds

THE whole civilized world at this moment of writing is interested in one thing, the counter-offensive. When will it start, how will it fare against the hordes of Hindenburg now engaged in their mighty and ferocious bid for a world decision?

But the great drives of the western front are not affairs of days or weeks. They come after careful preparation; some before this have taken months to run their course. And so with the counter-offensive. It must be deliberately well-timed, and it must have a duration in proportion to the sustained thrust it is designed to defeat.

Both these conditions have been happily fulfilled for our own share in the counter-offensive here at home. Possibly it has never occurred to a great many anxious patriots, scanning the headlines for some confirmation of hope in this critical time, that they have a personal and vital part to take in the effort to halt Hindenburg. This counter-offensive was started on Saturday, April 6, the anniversary of our entrance into this titanic struggle for everything that makes life sweet. It will last a month, following a schedule as carefully mapped out in advance as any the Germans have ever prepared for a march on Paris. Its result, a huge oversubscription to the Third Liberty Loan, will have carried every objective, financial and moral, which it is at present our function to carry in our majestic progress toward victory.

This is not a mere figure of speech which defines our Liberty Loan campaign as a counter-offensive. This is not a war simply of military and naval forces, but of whole nations, of the stay-at-home civilians of either sex and every age as surely and completely as of soldiers and sailors. At home the mobilization of money and industry for the prosecution of war, a process involving every inhabitant of the country when successful, is as vital a part of the vast conflict as the give and take across No Man's Land. With a great national response to this, the Third Liberty Loan, we Americans at home here, from three to six thousand miles from the scarlet waters of the Somme, are launching an offensive against Hindenburg as sure to hit his line as if we were plunging over the top tomorrow with bayonets fixed to attack his shock troops.

Keeping Down the Cost of Coal

THE United States Fuel Administration has adopted strict rules to govern the distribution of coal. Licensed distributors may not serve as middlemen unless their services are bona fide. If it is found that the licensee as purchasing agent has direct or indirect control of the mine owner, no commission will be allowed; or, if the licensee is in position to dictate to the mine owner and prevent him from selling to any consumer or retail dealer who has not employed the licensee as purchasing agent, it will be assumed that there is direct or indirect control. Any licensed distributor who attempts to obtain a purchasing agent's commission unless actually engaged as a purchasing agent will have his license revoked.

The object of this ruling is to give the consumer or retail dealer free choice as to whether he will employ a purchasing agent. Further than this, it is possible that all coal contracts made before April 1, 1918, will be declared void, thus putting the whole coal output on the market at the Government prices.

To public-utilities commissions, petitioned to allow increases of rates on account of the high cost of fuel, we suggest that raises, if allowed, be in the proportion that the increased fuel cost bears to the present price. Of the eight- or ten-cent rate to the small consumer it is a very small proportion; of the one- or two-cent rate to the big user it is a large fraction. There is no reason why the small user should be made to carry more than his share of the increased cost.

The old-fashioned wood engraver was unable to make a picture of a chimney without a picturesque cloud of smoke issuing from it, or of a machine without a man with a tall hat and cane in the foreground. The modern artist is still so possessed of the ideals of a past generation that he cannot depict an engineer without a workingman's cap with a visor on it.

Correspondence

Indexing Trade Literature

Trade pamphlets, circulars, catalogs, etc., are of value to the power-plant engineer and should be preserved; but when the engineer stops to contemplate the large volume that will accumulate in a year, he begins to realize that it is sometimes like hunting for the proverbial "needle in the haystack" to find the particular piece of information that is wanted unless some system of indexing and filing is employed.

Many of the large companies making a variety of articles issue large and expensive general catalogs which contain much information other than listing sizes, etc., and which are of value to the engineer or purchasing agent. Then there are bulletins and pamphlets which are of uniform size and intended to fit suitable binders. But there are many pieces of advertising matter received that are outside the scope of the plant and of only general interest to the engineer. For instance, the chief engineer of a department store using 220-volt direct-current service from his own plant will receive catalogs of, say, a new 150,000-volt transformer or hydro-electric machinery or relating to special street-lighting equipment, which represent considerable expense on the part of the manufacturer.

Many pamphlets, circulars and data sheets are sent out to supersede former issues on the same subject, and are usually so marked but not always. Unless they are marked, the engineer may keep both copies, thereby congesting his filing system and possibly causing confusion by getting the older copy when looking for information. Valuable data are in the many loose sheets which are received from time to time, yet they are difficult to save unless some system is followed.

In the modern manufacturing power plant trade literature on all parts of the plant is essential and, in addition to power-plant machinery, must include a variety of subjects, and the system used to keep these numerous pieces convenient for use will depend on the space available and on the ideas of the engineer.

One of the simplest yet efficient systems that has come to my attention is that of a public institution which receives a large amount of trade literature. In the system formerly employed all the large catalogs were numbered from 100 up, and the smaller pieces sorted out as to subjects as much as possible and placed in file boxes which were numbered beginning with No. 1. The large catalogs were numbered with a sticker on the back and set on the shelves, as were also the file boxes. A card index was then made of the subjects, with the file or catalog number showing just where the desired information could be found. After a few years this system outgrew the available space and a metal file cabinet was installed. This case has seven drawers 16 in. wide, 11 in. high and 24 in. deep. In each drawer there are from four to eight numbered index cards. The large catalogs are listed as before, and the small catalogs, etc., are given a file number beginning with No. 1, and as far as practicable sorted out as to subjects. It is not possible to do this in every case as there are many small catalogs that contain several separate and distinct items. A new card index of this literature was then made, and also another index of firms. If it is desired to find the catalog of a certain firm, it can be quickly done by referring to an index of firms.

The principal advantage of this system is that it is simple and compact. The hundreds of pieces of trade literature are kept where they are easily reached, and after the engineer has used the system for a few months he can, in many cases, find the desired catalog without referring to the index, provided it is replaced where it should be when used. After the system is installed, the work of keeping it up is slight. When a new catalog is received, it is numbered as to subject and an entry made on the proper index cards. About once a year the whole system is gone over, and obsolete and duplicate matter cleaned out.

J. C. HAWKINS.

Hyattsville, Md.

Burning Wood To Save Coal

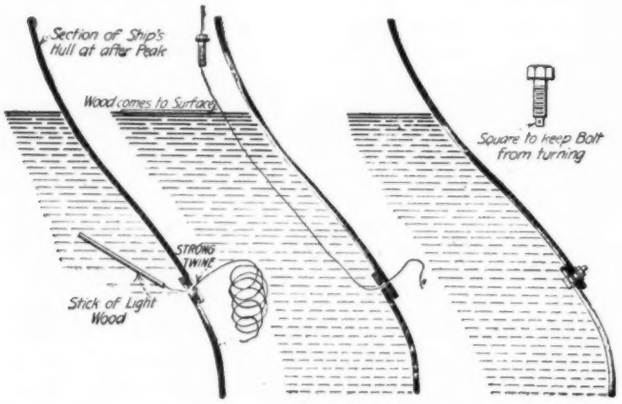
Commenting on G. N. McIlhenny's letter on page 194 in the issue of Feb. 5, I would say that there is no doubt that the substitution of wood for coal is entirely feasible and advisable under present conditions in many Southern plants, especially if good, dry wood is available. Full capacity may be had from almost any coal-burning boiler with dry wood, but not with green wood. Burning green wood entails great waste as a large percentage of the heat in wood is required to dry the wood itself in the furnace. It takes from three months to one year, depending on the kind of wood and climatic conditions, to thoroughly dry wood stacked in the open.

To successfully burn green wood a strong draft is required and a much greater distance between the grate and the boiler than is found in the ordinary coal-burning installation. In firing green wood the furnace should be kept "crammed full," replenished as fast as burned and the intensity of the fire regulated with the damper. I can say, however, from a wealth of experience that there will be few occasions to close the damper when firing green wood; the big worry is to keep steam if there is much of a load on the boiler. The idea of burning or drying the wood in the combustion chamber is no good. Besides the trouble of getting the ashes out, it would be necessary to let the fire die down to a certain extent to allow the fireman to get at the wood in the combustion chamber to drag it back on the grate. No boiler could be fired at half of capacity under these conditions. As to iron bars to protect the blowoff pipe, they might last a week, probably less, in the direct path of the heat under a hard-fired boiler.

Ash Fork, Ariz. W. G. CAMP.

Bolting a Rivet Hole Under Water

The illustration, "Bolting a Hole Under Water," on page 81 in the Jan. 15 issue, suggests that the artist had in mind a situation one may be up against on board a ship, although the necessity of closing a bolt hole under water may arise in connection with open tanks on land. The kink there illustrated, however, does not appear as certain of quick success as the one


Section of Ship's Hull at after Peak
Wood comes to Surface
Square to keep Bolt from turning
STRONG TWINE
Stick of Light Wood

METHOD OF BOLTING A RIVET HOLE UNDER WATER

shown herewith, which is an old catch at marine engineer's examinations.

The principal points against the first-mentioned method are that with even the slightest current or other disturbance of the water it would be rather difficult to get a hold on the string with the wire hook so as to fish it through the opening, and the idea cannot be used if the opening is at a joint in curved plates, as shown herewith.

However, as a practical expedient, I believe that a pine plug or one made of other wood that will swell greatly when in contact with water has its advantages, at least until such time as the insertion of rivets or bolts becomes conveniently possible. This temporary plugging with wood was once successfully resorted to during my experience as a marine engineer, when two rivets had jumped out of a joint in the ship's hull about 14 or 16 ft. below the water line. The plugs remained securely in place until the next dry-docking the ship underwent, which happened to be soon. Of course we could hardly have stopped the ship for such a comparatively small matter, and besides, as there was quite a sea running, the bolting "kink" would have been pretty hard of execution. H. J. VANDER EB.

Hartford, Conn.

Distant-Load Indicator

The following scheme is used in a system where it is desired to obtain frequent load readings at the office of the central station, the power plant being about a mile and a half away. There is no indicating wattmeter in the plant, but an integrating watt-hour meter measures the total energy supplied to a transmission line.

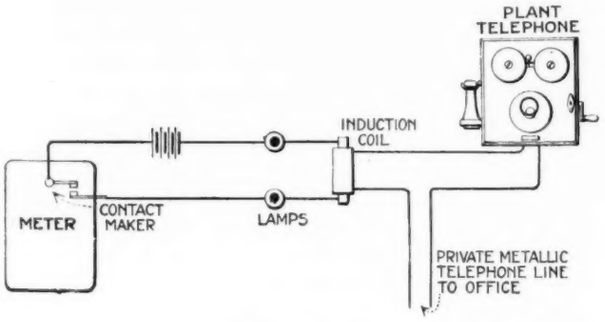
The register of the watt-hour meter was sent to the manufacturer, and a counting or contact-making device applied, which makes momentary contact for a certain number of revolutions of the meter disk. The company maintains a private telephone line between its office and plant, and the indications are transmitted over this line by means of the contact-making device shown in the drawing, wired so that its operation does not interfere with talking on the line at the same time the indications are sent.

Referring to the drawing, it is seen that the telephone line forms the secondary circuit of an induction coil. The primary circuit contains four dry cells and two 60-watt 110-volt type B Mazda lamps, the latter being used merely to act as rheostats to limit the primary current and inserted in each side of the circuit for protection in case the potential or current transformers supplying the meter should break down and subject the telephone line to high voltage, the supposition being that the lamps would either light or burn out in case of trouble.

As a further precaution and also to reduce noise on the telephone line caused by possible leaks in the meter or its transformers, the induction coil is specially constructed, the primary being wound around a core 0.25 in. in diameter, made of No. 18 soft-iron wire and inserted in a glass tube, the secondary coil being wound on the outside of the glass. The induction coil, when finished, is 3.5 in. long and 1.5 in. in diameter. The glass tube was obtained by cutting off a section of a round vial. The coils are wound with No. 30 single cotton-covered wire, there being approximately 2500 turns in the primary and 2000 turns in the secondary.

The primary circuit is closed by the contact-maker in the meter, and this produces a faint though audible click in any receiver of the telephone sets on the line.

The time between two successive clicks is inversely proportional to the load being registered by the meter,



WIRING DIAGRAM FOR DISTANT-LOAD INDICATOR

and with a stop watch and the following table, the load at the plant may be determined from any station on the private-telephone line:

Time Between Successive Clicks, Seconds	Kilowatt Load
10.6	100
15.9	75
21.2	50
42.4	25

The complete table used by this company gives the load in kilowatts for every 5 kw. from 5 to 150, and the corresponding time in seconds. The table must, of course, be calculated for the installation it is used on, from the disk constant of the meter, the ratio of the reducing motion on the contact maker and the ratio of the transformers. R. S. SEESE.

Carthage, Tenn.

Heat from the Atmosphere a Substitute for Fuel

Technically, this proposition is known as perpetual motion of the second kind, and is commonly believed to be nothing more than a mere chimera, simply because the idea of its realization seems to be absurd. In the particular branch of science which treats of the motive power of heat, treatment of this idea as chimerical is the fundamental dogma from which is derived the so-called "second law of thermodynamics" and underlies the entire science as it is taught at the present time.

In the year 1824 Sadi Carnot, a noted scientist of France, demonstrated that realization of perpetual motion of the second kind meant the effect of combined action of two distinct heat engines, one acting as a heat pump driven by the other acting as a heat motor; furthermore, that the motor must be operated by a working substance that is more efficient as a medium for converting heat into work than the working substance which is used in the pump to produce a reversed effect.

Carnot stated that realization of this requirement must be impossible simply because its resultant effect would be absurd; and in accord with this assumption he concisely formulated the following principle which bears his name, and is considered the best formulation of that dogma: "The efficiency of a thermodynamic reversible cycle is independent of the working medium." Stripped of all camouflage, this is the real question which the United States Government must settle if it undertakes to investigate the feasibility of obtaining free energy from the atmosphere.

Unfortunately for the cause of the advancement of science, at various times individuals possessed of various degrees of honesty and knowledge of the subject have appeared in the limelight and failed to deliver the goods in regard to this question of free energy. However, it may be said that present-day experimentally derived knowledge of the physical properties of elastic fluids indicates that Carnot's postulate is fallacious; and as a consequence obtainment of free energy from the atmosphere, and in fact from all matter possessed of temperature, is not necessarily impossible.

Milwaukee, Wis. JACOB T. WAINWRIGHT.

Different Rate of Scale Formation

Replying to Mr. Pascoe in the issue of Apr. 9, page 521, I would suggest that the scale formation is greatest on the side of the boiler nearest the soot-blowing openings, because there is less soot on the tubes on that side, therefore the heat transfer is better and more water is evaporated in these tubes; hence the extra scale.

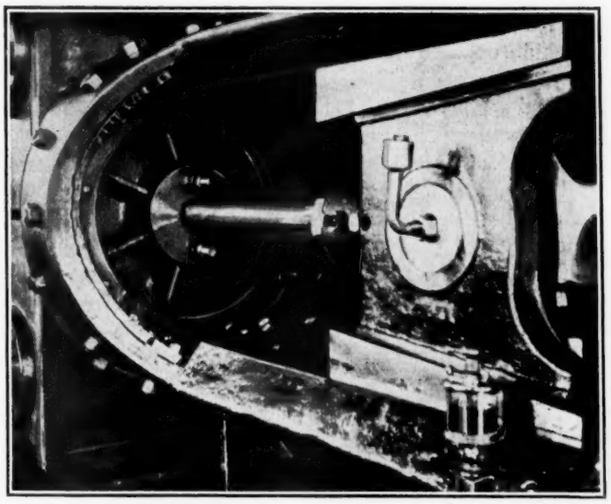
New York City. J. LEWIS.

Corliss Engine Frame Repaired

About three years ago I found that the frame of our 18 x 42-in. Corliss engine was cracked where the flange on the frame is faced to receive the cylinder head. The first method of repair thought of was to have the frame welded, but while many firms would undertake the job none would guarantee it to be a success on account of the strains set up by the process, so I decided to patch the frame with a piece of boiler plate.

As may be seen in the illustration, the recess back of the guides is considerably larger than the bore of the guides themselves. The distance from the end of the guides to the end of the frame is 8 in. and the diameter back of the guides 24½ in. From these dimensions I gave the boilermakers an order to form a cylinder of ⅝-in. boiler plate 24½ in. outside diameter, 8 in. long, with a 4-in. flange turned inward on one end. When the blank came, it was faced on the end that was to be placed against the finished end of the frame under the cylinder nuts, and was then laid out and drilled for the cylinder studs.

The problem then was to get as much of this flanged cylinder in back of the guides as possible. I had decided upon two-thirds of it going in one piece, but exactly how it was to be put in was not fully decided until a friend came in and suggested that I make a galvanized



REINFORCEMENT PLATE INSIDE OF ENGINE FRAME

iron templet like the patch and then cut it in two parts in order to ascertain how large a part of it would go in place.

Then the old cylinder studs were all taken out by drilling a ⅜-in. hole, half in the stud and half in the nut, inserting a piece of ⅜-in. round iron to lock them and unscrewing with a 1-in. solid-end wrench. The patch was heated, using charcoal, closed, put in and opened out, or expanded, with bars and jacks, and long tapered wedges were driven between it and the ends of the guides to keep it forced back in place. At first it was thought that rivets would be good to fasten the plate in place, but it was decided that turned bolts ⅞ x 4 in. would be the best with the holes drilled 2 7/32 in. and reamed to a driving fit for the ⅞-in. bolts. When finished and the cylinder studs put in and drawn up tight, it made a good job.

The drilling was all done with an air motor and the reaming by hand. The total cost of the job was $90, and the engine was out of service five nights. This job was done three years ago and has proved perfectly satisfactory. None of the bolts ever slacked enough to require tightening up at all. J. T. SHARP, JR.

Canton, Miss.

Cook Boiler Explosion at East Chicago

I have read the interesting article on page 382 of the Mar. 12 issue of *Power* on the explosion of a Cook boiler, and the cause of the accident. In a case of this kind all have a right to an opinion as to the cause of the explosion, and I can hardly agree with the deduction as published.

It is stated that the initial fracture occurred in the joint or flange connecting the center tube to the lower tube sheet. It is further expressed in opinion that this type of construction is wrong. Cook boilers have been in operation for about 25 years, and it seems rather a late date to discover an error in construction. Had there been a defect in the design of the boiler, it would have appeared a great many years ago. The illustration, Fig. 2, as published, of the lower drum after the explosion shows the lower tube sheet drawn up into a shape of a bell. This indicates, in my opinion, that the center tube held to the tube sheet and was the last portion to give way. It indicates that this was the final rupture and not the initial rupture. In discussing the explosion of a boiler after it happens, we are prone to criticize the design and give too little attention to the care and management. The statement to the effect that some twenty tubes were renewed just previous to the explosion indicates, in my opinion, the prime reason for the explosion.

The tubes in a boiler of this type which are renewed frequently are those in the front bank facing the fire. In a boiler used for utilizing waste heat these tubes will be renewed several times in 17 years. The repeated rolling will enlarge the tube holes, and the result is that when new tubes are put in, they will not hold if care is not used in rolling. It is my opinion that the new tubes were not properly rolled into the lower drum. They were probably surrounded by other tubes that were warped and consequently pulled out of the lower drum, causing the explosion. It is not unusual for an inspector to find tubes in the lower drum of a boiler of this type improperly rolled. The short drum and the stays make it somewhat difficult for the boilermaker to work in this position, and he is liable to slight the job.

It is also stated that the boiler was fired up from a cold boiler in one hour. This is an unusually short time to fire up any boiler, but I can hardly agree that this particular type is less likely to stand it than any other. The reputation of the Cook boiler was based on its free circulation and quick steaming qualities, and its popularity as a waste heating boiler, and was based on every quality which the report indicates it lacked.

G. W. COOK,
Senior Inspector, Travelers Insurance Co.
Springfield, Mass.

In *Power's* report of the boiler explosion at East Chicago two theories were mentioned as to the cause and each involved unequal expansion, caused no doubt from hard firing. The report says, "One hour before the explosion the boiler had been fired up cold and within this period the pressure had built up to 50 lb.," which in itself explains the primary cause, for no boiler will stand that strain for long.

Engineers and firemen do not fully realize the strain caused by unequal expansion in firing up a cold boiler in two hours or less—something has to give way sooner or later if this practice is kept up. Boilers and settings should be warmed up gradually, and what applies to boilers also applies to steam lines, only with the latter one must be doubly vigilant in order to get rid of the condensation also.

W. H. H. PLOWMAN.
Philadelphia, Penn.

[It is not always possible, in fact, it is often impossible, to determine the exact cause of a boiler explosion, because it is usually so badly demolished. In this instance information has been received to the effect that the lower tube sheet was much thinner at the line of fracture around the center flange. The first impression seemed to be that the thinness was due to corrosion, but it has since been determined that it extended uniformly all the way around at the turn of the flange, and it is the opinion of experts that this thinness is due to the flow of metal at the time of forming the flange. In conversation with William H. Boehm, vice president of the Fidelity and Casualty Co., regarding the subject, the following case was cited as bearing out this opinion. Mr. Boehm said regarding the thinning of the material at the turn of the flange head:

> Several years ago, when a boiler exploded down in Mississippi, we found a similar condition; that is to say, the condition where the drumhead was about ⅛ in. thinner at the turn of the flange than elsewhere. We inspected similar drums in the same plant and found that their drumheads also were thinned by the flanging process. We wrote a little article on the subject at the time, and it is my understanding, mostly on this account alone, that it has been the practice in recent years very greatly to thicken up the heads of drums and tube sheets likely to be thinned by the flanging process.

Mr. Boehm is of the opinion that investigations of such explosions will show that the most likely cause for such accidents is due to this thinning down of the tube sheets by the flanging process, together with the crystallization that has been going on during the period the boiler has been in service. Furthermore, unfortunately, it is not possible, through ordinary means of inspection, to discover a condition of this sort. Even if all the tubes in a boiler have been removed, the thinness of the metal at the turn of the flange would not manifest itself, as the edge of the nozzle and also the edge of the flanged part of the head would show the usual thickness. The best way to make a determination of this sort would be to drill a small hole in the turn of the flange and then to measure the thickness with a short piece of bent wire. Boiler inspectors would hardly resort to such a method and boiler owners would probably not permit the drilling of the head at this point.—Editor.]

Correction Regarding the Use of 85 Per Cent. Magnesia

In my statement, "A Correction Regarding the Use of 85 Per Cent. Magnesia," appearing in *Power*, Apr. 2, 1917, issue, at the top of page 484, lines 2 and 3 read: "a reprint of a report made by the Mellon Institute on heat-insulating materials." This should read: "a report made by Sargent & Lundy on heat-insulating materials."

E. R. WEIDLEIN,
Acting Director,
Mellon Institute of Industrial Research, University of Pittsburgh,

Inquiries of General Interest

Damage from Handhole Cover Dropped in Water-Leg—What damage would result from dropping a handhole cover and leaving it in the water-leg of a locomotive boiler?

A. H. B.

There would be practically no harm done, unless the handhole cover was lodged at or near the bottom of the water-leg in such a position as to cause accumulation of sediment that would endanger the fire sheet to burning.

Shaft Out of Line with Cylinders—If the cylinder center lines of a twin-cylinder hoisting engine are parallel and the shaft center line is ⅜ in. below each cylinder center line, will the difference of level affect the operation of the engine?

H. M. N.

In a hoisting engine of ordinary size, the discrepancy would make no appreciable difference in the wear or operation of the engine.

Pitch Required To Retain Given Percentage of Plate—With rivet holes ¾ in. in diameter, what pitch of rivets would retain 70 per cent. of the solid plate along the pitch line?

A. H.

To have 70 per cent. of the material retained along the pitch line, the material removed for ¾-in. diameter holes would amount to 100 − 70 or 30 per cent., and therefore 100 per cent. of the pitch, or the distance center to center of ¾-in. diameter holes, would need to be ¾ in. ÷ 30 per cent. × 100 per cent. = 2½ inches.

Lap, Lead and Angular Advance—What is meant by the lap and the lead angle and angular advance of an eccentric?

C. B. S.

The lap angle is the angle through which the eccentric must be set more than 90 deg. in advance of the crank to have the valve moved far enough to obtain admission of steam at the beginning of the stroke. The lead angle is the angle through which the eccentric is set in advance of the lap angle to obtain the lead or amount of valve opening at the beginning of the stroke. The sum of the lap and lead angles is called the angular advance of the eccentric.

Apparently Excessive Water Metering—What reasons can be given why the metered water consumption of an office building reported for the month of February should be much in excess of the ordinary monthly consumption? The meter was pronounced correct at the end of the period and there was apparently no unusual use or waste of water.

E. H. H.

Prior to the month in question, the meter may have been "too slow," though it is probable that if pronounced correct at the end of the period, the previous rate of error was not materially different. There may have been a larger supply than usual during this coldest month of the year to make up such wastes as leaving taps open to obtain hot water, or circulation to prevent freezing; or there may have been unobserved wastes of water, as from leaky tank valves or a leaky boiler blowoff valve. Another cause for an apparently higher metering, and one that is largely responsible for popular distrust of meters, is that the final registration charged against the particular month may have been read down closer than usual, thereby including an accumulation of meterings that belonged to a prior period.

Determining Benefits of Aligning Shafting—What methods are employed to determine the benefits derived from lining and leveling shafting of a power plant?

G. H. W.

The benefit of truer alignment in reducing bending stresses will become apparent from reduction in frequency of breakages, less wear and cooler running of bearings from less loss of power from friction, requirement of less lubricant and less vibration of bearings, hangers and other supports. The actual benefit of reduction in power required for overcoming friction must be determined by measuring the power required for driving the shafting before and after it is aligned. For complete information, the improvement should be ascertained with respect to both the bare shaft and with the shaft carrying its regular load. The relative power required by the unloaded shaft will usually be the better index on account of difficulty in obtaining the same load before and after the shaft is lined. For making a comparison, the best method of measuring the power is by means of a transmitting dynamometer, using the same instrument under identical conditions; or by ascertaining the input to an electric motor when used for driving the shafting and whose efficiency has been calibrated for the conditions. Comparable measurements of power may be made with sufficient precision for most practical purposes by carefully indicating the regular driving engine without change of any of its adjustments that would alter the friction of the engine. The diagrams should be made with steady speed of the engine and lowest steam pressure and scale of indicator spring compatible with the load, so as to obtain diagrams that can be measured with greater accuracy.

Obtaining Required Length of Piston Rod—How would dimensions be taken for the length of the piston rod for an engine?

J. E. R.

The important consideration is to provide length suitable for securing equal piston clearance at each end of the stroke. For this purpose, first determine the required finished length from the piston to the crosshead. Having the shaft square with the cylinder center line, and the connecting-rod in place with brasses shimmed to give the average length of connecting-rod, make a mark on the crosshead to register with a mark made on the guide when the crank is on first one dead-center and then the other. The distance between these marks on the crosshead will be the actual length of stroke. Place the piston in the cylinder with a distance piece or pattern of hardwood on the cylinder-head side of the piston, to represent the dimensions of the piston rod with nut or other fastenings that are to project beyond the piston. With the cylinder head in place and piston with distance piece firmly pressed against the head, mark on a wooden rod the distance from the piston at the bore of the piston rod to the outside of the piston-rod stuffing-box, and on the same end of the measuring rod mark the distance from the same part of the stuffing-box to the same part of the piston while it is pressed hard against the crank end of the cylinder.

The difference of distance between the marks thus made on the measuring rod and length of stroke previously laid off on the guide will be the sum of piston clearance distances obtainable for both ends of the stroke. To provide for equal clearances, make a mark on the guide at one-half of this distance, measured toward the crank, from the crank end of the length of stroke previously marked on the guide. After disconnecting the connecting-rod, place the crosshead so the mark previously made on it comes opposite to the mark last made on the guide. Then with the piston hard against the crank end of the cylinder, rod the length for the finished piston rod from the end of the crosshead bore to the end of the bore of the piston. The additional length and dimensions required for machining the ends of the new piston rod will be governed by the design of the piston and crosshead.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

The Marine Engineer and His Work*

By AN EX-MARINE ENGINEER

This is not a technical discussion, but is intended to illustrate by a few experiences, the duties and responsibilities of engineers on board a North Atlantic greyhound.

WE WILL imagine ourselves at the pier in New York, having just arrived in port, and will go below and begin preparations for another voyage. As soon as the telegraph from the bridge rings, "Finished with the engines," all safety valves are raised by the easing gears, the main stop valves are closed and the fires drawn in all but two of the main boilers. As soon as fires are drawn, the water in the boilers is pumped overboard, the manhole doors are taken off, the smokebox doors are hoisted, and the work of withdrawing the retarders, some 6600 of them in number, and cleaning the tubes is begun by the shore gang, numbering about 150 men. By the time the tubes are cleaned, the boilers are cool enough for the men to go on cleaning the furnaces and combustion chambers, and then the work of scaling the boilers is started. We generally found on the furnace crowns a deposit of salty scale ranging from $^3/_{32}$ to $\frac{1}{8}$ in., each run.

In the meantime the engineers having general supervision of this work are "passing the tubes," which means having a light held at the back end, passing along from tube to tube, and when one is found choked up, chalking it; then in turn inspecting all the furnaces and combustion chambers inside and out, stay-bolts and nuts, tube ends, boiler shells inside and out, all main lines of piping, valves, and in fact every piece of metal visible to the naked eye; withal keeping watch of the boilers under steam. As soon as two boilers can be cleaned and steamed up for the auxiliary service, the two that have been running are taken off and made ready like the others. While the cleaning is going on, a large crew of boilermakers are expanding tube ends, fixing air casings, calking seams which leaked at sea, repairing furnace doors and their catches—which, by the way, is of no small importance, for a steamship's furnace door must stay open until it is closed and stay closed until it is opened; otherwise, with the Howden forced draft, which we had, there will be some severely burned faces as a consequence. The blowing engines are also gone over as carefully as the main engines.

Boilers the Foundation for Good Records

In regard to the care of steamship boilers, or any other boilers under pressure, do not fail to see everything that can be seen, for bear in mind the boilers and their output are the foundation for good records both at sea and on shore.

In the engine rooms in the meantime the work is going on in the following order: Upon receiving the "finished with the engines" signal, the turning gears are connected and two of the most trusted engineers are sent to sound the shafts, this being done by screwing together a sectional sounding-rod about forty feet long, which is carefully machined at each end of each piece and screwed together till it butts metal to metal. This rod, as it is made up in the gloryhole aft (or what would be called the " 'tween decks" over the propellers), is passed down through a cupped opening onto the shaft near the propeller bosses and the exact height recorded on these rods after each run. When the shafts are found down or deflected more than a certain prescribed limit, they must be lined up or there will be a repetition of the "Paris" disaster back in the 80's, when the shaft was said to be down 1¾ in. at the point where it failed. Incidentally, one of the senior engineers is liable to happen along at the time the readings are being taken.

The circulating pumps on the main condensers are stopped, feed pumps connected by lines of hose to dock hydrants, the exhaust of the auxiliaries put into the auxiliary condenser or to the atmosphere and the steam cut out of all lines of pipe not in use, which means the closing of not less than 30 valves; and the work of overhauling the engines and pumps is now begun by the "shore gang," the ship's crew being off duty with the exception of three or four engineers until the next morning to get at least one full night's sleep or a run on shore—probably the latter.

Work Done in Port

As an example of the work done while in port, my notes taken on board the "St. Paul," when I had charge of her starboard engines, will serve, about the same work going along on the port engines. First entry, "Stripped and examined forward high-pressure piston." This work is done by one of the junior engineers with four or five firemen to assist. We generally found the wear on the piston packing rings in the high-pressure cylinders very severe, due to the high steam temperature, occasional priming which carried over more or less dirt from the boilers, and the very moderate use of cylinder oil, which for these large engines is not over one drop through the lubricator per minute, and frequently no oil at all is used. Sometimes we would find only a few pieces of the packing rings in the piston. This, however, was not a difficult repair, as we always carried spare rings, which were sawed diagonally across and left apart an eighth of an inch when in the cylinder to preclude any chance of cramping. These high-pressure rings are usually the ordinary snap rings called "Ramsbottom," and this same type of packing is used in marine-engine cylinders up to 50-in. in diameter; above that size, light steel springs are used to keep packing rings against the walls of the cylinder. Follower bolts were renewed occasionally as we often found them crystallized to such an extent that, laid across the jaws of a vise, they would break with a very light hand-hammer blow; while when new they could be bent double on themselves without fracture. To make sure that the follower bolts were screwed down tight enough, we generally provided the men with a light steel bar which was to be bent on every bolt in making it up.

"Overhauled piston-rod packing on aft high-pressure rod." "Examined second intermediate piston, found 12 springs broken, replaced with new ones." To do this on a 77-in. cylinder, we had a small manhole in the center of the cylinder cover through which we could enter without taking up the cylinder cover proper.

"Universal couplings on throttle-valve gearing repinned." "Overhauled and adjusted first and second intermediate valve-spindle guides." "Put lighter oil cups on all crossheads." A great fault of oiling service was that heavy cast-brass cups were held in position by light slot-headed screws, which never ought to be used except for holding the cylinder lagging. These cups are better if made of sheet brass and held in place by capscrews.

"Overhauled low-pressure crosshead." To properly overhaul crossheads, we generally had to hang the engine up, take the crosshead brasses off the rod and chip side clearance in the boxes, filing and scraping them before putting them together, for very often we would find the crosshead pins afloat; that is, not bearing in the bottom of the box after the engines had cooled down from a hard run. When we had the crosshead landed in the boxes, after giving the boxes side clearance, we adjusted the amount of running clearance between brass and pin by the use of wire made of pure lead and very soft. This adjustment is made by laying the lead wire across the pin at right angles to its axis and a little short of its half-circumference, one wire about an inch in from each end and one in the center, putting in the liners and putting the top half of the box and binder on and screwing the nuts hard down on the lead wires, marking the nuts before slacking them up so as to have a record of their position. Then, by putting in or taking out liners as required and by taking a final lead impression, we adjusted

*Informal talk before the graduating class of the Massachusetts Institute of Technology.

these boxes to a clearance amounting to about a thousandth of an inch by micrometer calipers for every inch of diameter of pin or bearing. This method is used for all bearings of marine engines where adjustments are to be made.

"Found piston nut slack on forward circulating engines, and one follower bolt broken." "Reciprocating parts of these engines thoroughly overhauled." "Renewed oil-piping systems on high-pressure valve gear, which was thrown off at sea." "Sawdust connection put on condenser circulating pumps." This was done so that we would be able to inject sawdust into the condensers when leaking. "Air-pump valves and feed-pump valves and seats examined and renewed where necessary." "Filter cloths renewed." "Two copper bends (a practice now abandoned) put into auxiliary steam mains, reducing valves, main to auxiliary thoroughly overhauled, adjusted forward l.-p. crankpin (this adjustment being similar to that of the crosshead, except that we rarely had to give boxes additional side clearance)."

A word about the bedding of the main crankshafts of these ships and about the use of water on hot bearings is probably in order at this point. There is a difference of opinion in regard to the use of salt water on hot bearings. On one new ship we were permitted to use water on the bearings when they were above 110 deg., and this shaft went down uniformly about $\frac{3}{4}$ in. in all its bearings in about twelve months' running. In another, a sister ship, we had orders not to put the sea water on until the thermometers in the bearings (which are hung by wires just clear of the revolving shaft) registered 180 deg., or thereabout, but this shaft went down considerably more and gave a good deal of trouble. It is my practice to keep the temperature down, water or no water.

"Thrust bearing pumped out and refilled with clean oil." Thrust bearings require a great deal of attention and should be closely watched. When they do go wrong, they give a lot of trouble and are hard to handle. "Plates put over two bearings underneath platforms to keep dirt off; hotwell cleaned out." "New water end put in main boiler-feed pump and any number of small jobs too numerous to mention." Boiler-feed pumps on all the ships that I was ever in were about half large enough; technically speaking, they were ample, but in practice we were greatly bothered with them, especially with broken valves, split water ends, broken pistons and piston rods, feed pipes and feed-pipe anchorages, packing blown out of joints, etc. These should have ample margin, so that they can be run slowly.

Washing Down and Painting

On the day before sailing, after all this examination and repair, the washing down and painting is started and the engine rooms are all "slicked up" ready for sea, tools and tackle are all stored away and the boilers closed up and filled with fresh water from the dock. The last half-day before sailing, the ship's engineers are given another short run on shore, sailing hour being at 10 o'clock next morning. At 8 o'clock the night before sailing, the bottom fires in the boilers are lighted under the supervision of one of the senior engineers, who makes it his particular business to see that the water is well up in every one before the fires are lighted and that all the stop valves are opened from the cold boilers; he also sees that the main throttle is "cracked" in order that all the main lines of piping right through to the engine cylinders are warmed up gradually with the boilers. After the fires are started the men of this crew take one turn out of both main engines with the turning gears, first looking the engines over carefully to see that nothing is in the way, that all the small parts are connected, that the crankpits are clear and all is right for running. The turning gears are then disconnected so that, if the engines should move while the cylinders are being warmed, no damage would be done. This is all the trial these engines have before going to sea.

At midnight the high fires are lighted in all the main boilers, Scotch marine type, and the circulating of the water in them commenced. One boiler is taken at a time, and the water is pumped from the bottom of the boiler and back into it again, through the feed pipe, to warm the bottom of the boiler shell and surrounding parts under the fire line of the furnaces, so as to equalize the expansion of the shell. This is a very important part of the process and is under the eye of one of the senior engineers, for a little carelessness might mean the pumping out entirely of one boiler and the flooding of two or three more.

In the meantime the manhole covers in the bottom of the boilers are followed up and every water pocket in all steam mains is carefully drained, for the steam pressure now is 20 or 30 lb. and by 4 or 5 o'clock has reached 100 to 120 lb. The engineer and two assistants go all over the engine department, setting the main valves as they are to be run for the voyage—some of the main stop valves on the boilers are run 2 to 6 turns open, to retard priming where the draft of steam to the engines is heavier than to others. At 8 o'clock in the morning the 8 to 12 watch is detailed below "all hands," and begin filling the oil cups, start the main condensers, prove the telegraph, try the reversing gears and complete the warming up of the cylinders of the main engine, but do not start the main engine.

Getting Under Way

The stokers are given their stations, trim the fires and gradually raise the steam to about 195 lb. Occasionally, at about this time there are little things such as stay-bolt nuts giving way in the combustion chambers or tube ends leaking badly; this means that fires are drawn from the boiler affected and a lot of man-killing work, twelve or fifteen of the shore gang being kept to lend all the assistance they can. Finally, the "all ashore" is sounded and we are left to our own devices and the next thing we hear is "half-speed astern," for the two 10,000-hp. engines, which have each been dismantled in a dozen places and readjusted. Every order of the telegraph is registered in minutes and seconds in writing in a log book. This order is no more than carried out until we have "full speed astern, both engines" to carry us out into the river against the tide. All hands except the chief engineer are below, to assist in getting under way, handling the engine, etc. After a series of "half-speed ahead," "slow ahead," "stop," one side and then the other, we drop the pilot and get the "full-speed ahead" double order, and sometimes if the skipper is feeling extra well, triple order, and the real business of driving a greyhound across the Western ocean begins.

Here is where all the bad work done in port shows up; although every bit of the work was done under the eyes of the engineers, more or less of it had to be intrusted to a gang of machinists who are not engineers and who came aboard ship to get in time. Some of the bearings were adjusted too closely, some improperly put together, so that the first watch at sea between poor firemen and hot engine bearings is often a "hot one." Again, we might leave port without a particle of trouble. In regard to the driving of one of these ships, I wish to say a word about a man's personal character. Above all things, he must be a *man*, say what he means and mean what he says; for in so large a crew of men there are all sorts of dispositions, and in order to get the ship along, a man must have a level head and be more or less a manipulator of men as well as of engines; for if you are not a steam getter, your engineering ability will count for naught. Habitually following one revolution per minute behind the other watches, you will be called up to explain why. Sometimes the men claim to have a poor crew—that's easy; the chances are that the next time you leave port you will have the best watch of men on the ship, or the watch that has made the best time, and then if you fall short, your number may be called. It is a business proposition from start to finish.

On going below to take charge of a watch, the senior engineer will look over the gageboards, see that the reading of the revolution counters for the previous watch are properly recorded at 8 bells. In the meantime his watch of men has gone over the engines to see for themselves that everything is all right. The stoke-hole engineers at the same time have gone through the stoke-holes taking in the average height of the water in the boilers, the amount of coal in front of the boilers and the general condition of things under their supervision. If nothing is reported wrong inside of ten minutes, he will turn to his fellow senior with the words, "I've got her." Should anything be found wrong—for instance, low water in the boilers, hot guide, main bearings, a hot crankpin, eccentric straps, or the like—he may refuse to take the watch until the ir-

regularity is straightened out. Should the water in the boilers be exceptionally short, for instance, he might go on deck till more water is put into the boilers. Or if it were simply a broken-down auxiliary which could be temporarily stopped for repairs, the required number of men would be detailed from the watch being relieved to make the repairs; these men would work for two hours of the watch coming on, when the same number of men would be brought down from the watch coming after—so that any number of men would be liable to be below eight hours on a stretch, for on a "liner" you are with your job all the time.

Troubles Not Always in Engine Room

The following will show that all troubles are not in the engine room. Once, in leaving New York, one of our coaling ports in the ship's side had not been properly secured and just as we were nicely ploughing into a February nor'easter, the door swung open, shipping water in "great shape." It was on my watch and I sent an assistant to tell the chief in person what had happened, thinking it might be necessary to "heave to" or "put the good side to the weather," but I started at once with six men to try to make the door fast between seas. We had no more than reached it when a fire in the dynamo room put the ship in total darkness temporarily. Between getting the door fast, putting oil torches by the side of water-gage glasses and about the engine rooms, we were busy. But after an hour or so we had some of the lights on and made the run without any further trouble.

Another time we were nicely around "the corner" of the Banks of Newfoundland, when a forward port main-bearing stud broke. This was handled about as well as any break of its kind I ever saw. First of all the turning engines were put into gear so that the main engines would not move while we were working over them. We then put a large ring spanner or solid wrench encircling the nut on top of the bearing over the nut; the wrench by the way, weighed about 300 lb., the stud being 6 in. in diameter. This was securely lashed close up to the bearing cap with chains, tightened by a "Spanish windlass" and chain-falls. For additional holding-down power we took one of the cargo-hoisting booms and cut it to reach from the cap to the reversing-shaft bracket, securely lashing top and bottom ends in position. After the turning gear was taken out, we were able to proceed for the rest of the voyage at about half-speed with this engine, occasionally tightening up our rigging.

Shortage of Water Causes Trouble

In regard to the possibility of the boilers being short of water, we were once westward bound, about four days out, running in a heavy beam sea. Through some mistake in a pumping order, two of the ship's trimming tanks were not entirely pumped out, and the ship made one tremendous lurch to port, about 37 deg. from perpendicular, as I remember it, and owing to slack water in the trimming tanks, held there for quite a period—long enough to melt the fusible plugs in five boilers at one time (the fusible plugs being in the side combustion chambers). This meant drawing fires out of forty furnaces (for the boilers were double-enders with four furnaces in each end, half a ton or so of incandescent fuel in each), the closing of the stop valve on each of these boilers and the releasing of the steam through the safety valves by the easing gears before we could get in the combustion chambers to screw brass plugs into the fusible plugs in place of the fusible metal. We accomplished this with a long socket wrench, lying on our backs on planks on top of grate bars which only a few moments before were covered with incandescent coal. You can imagine what this meant. We had sixty men from another watch to help draw the fires and rekindle them, while coal, wheelbarrows, red-hot rakes, slice bars and the like were thrashing from one side of the ship to the other. I have known of fusible plugs being temporarily plugged by very adept men when there was 30 to 40 lb. pressure in the boilers.

Occasionally, in going across we fall in with another ship of our own class going in the same direction. I remember in particular one time when we fell in with the "Campania." We can always tell by the smoke whether it's a ship with anything like our time or not, for if the smoke remains on the horizon an hour she is with us to stay. In coming the other way, we have her nicely abreast in an hour. We sighted the "Campania" astern about 8 o'clock one morning. At 8 o'clock the next morning she was just about abreast, a "stern chase," and at 8 o'clock the following morning her smoke was just in sight ahead, with practically one-third more power than we had, which speaks pretty well for the smaller ship. In the meantime they, in the forecastle, began to take a great interest. The 8 to 12 watch the first morning went below with a full determination to beat all previous records, which they did. The 12 to 4 in taking charge, found stars chalked all around, on the boilers, on wheelbarrows, in coal bunkers and even way up on top of coal piles, showing they had been up there for lump coal, for they certainly did not go up there to sleep. These came off watch with a better record and more stars and more revolutions made per minute. Not to be outdone by any of the other watches, the 4 to 8 went below and made a still better record, which I believe was the highest ever made by that ship before or since. I went forward myself to be sure this watch was properly called, and found them all ready to go below half an hour ahead of time. We had a one-armed fireman on this watch who was born for better work. He had been around the world probably a dozen times, and he said to me: "I heard them 'breaking her up' on the other watches, and I thought I would get the boys ready. She's making such good time I couldn't sleep for her turning." He was my mascot as long as I was in the ship and the boss of the watch in the forecastle. There is another point which I wish to bring out in regard to marine engineering, and which I will illustrate by an incident that happened on board the "New York." We were within twelve or fifteen hours of port when the connecting-rod broke on one of our fan engines, almost wrecking the engine. We could have made the run without this engine, but to go into port with anything broken down was not in our book. The word "helplessness" is not known in the business. The engine was properly repaired, a new spare crankshaft being put in in place of the old one, the frame patched with steel plates, and the engine made as strong as originally, the work being completed about two hours before we reached port.

The Coal Situation in France

Before the war France consumed a total of approximately 65,000,000 tons of coal, of which, in round figures, 41,000,000 tons was of domestic production and 24,000,000 tons was imported from Great Britain, Germany and Belgium. The monthly consumption in peace times thus amounted to 5,400,000 tons. In 1916 the domestic mines produced only 20,000,000 tons and the imported coal amounted to only 19,000,000 tons, making the total quantity available for consumption 39,000,000 tons. In November, 1916, a typical month, the French mines produced 1,800,000 tons of coal and the imports amounted to 1,500,000 tons, the available monthly supply being therefore 3,300,000 tons, which represents a deficit, compared with the monthly consumption in 1913, of approximately 40 per cent. It should be noted, however, that the average for 1913 includes also the summer months, whereas the consumption is necessarily greater in the winter months. The figures for December, 1916, compared with the monthly average of 1913, indicate a diminution of 44 per cent.

The most hopeful sign, pointing to the unlikelihood of a serious coal crisis during the remainder of the present winter, is furnished by the great increase in the domestic production of coal. In October, 1915, the French mines produced 1,700,000 tons; in October, 1916, 1,800,000 tons; in October, 1917, 2,782,000 tons. In November, 1915, the French coal mines produced 1,500,000 tons; in November, 1916, 1,600,000 tons; and in November, 1917, 2,690,000 tons, or an increase of about 80 per cent. in the two years. It should, of course, be noted that the invaded portions of France contain the principal French coal mines, and that therefore the war has cut off the chief source of supply and has made necessary the more intensive exploitation of the mines in the uninvaded regions.—*Commerce Reports.*

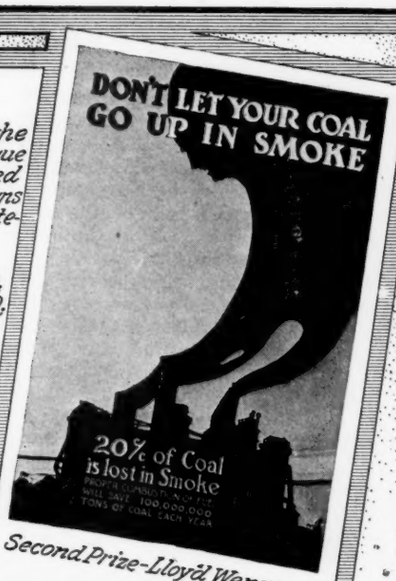
As announced in Power of February 5, the Smoke and Dust Abatement League of Pittsburgh in February conducted a competition to secure poster designs showing the relation of smoke abatement to fuel conservation.

Prizes were offered as follows: First prize, $50; second prize, $20; two prizes, $5; four prizes, $2.50; ten prizes, $1.

The winner of the first prize was Lawrence Kritcher, a first-year student at the School of Applied Design, Carnegie Institute of Technology.

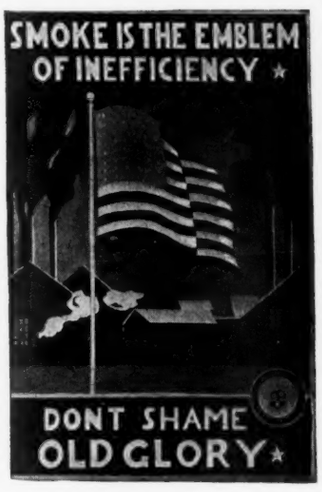
Reproductions of seven of the prize-winning designs are shown on this page.

First Prize—Lawrence Kritcher



Second Prize—Lloyd Wenunger

One of the Fourth Prizes—Mildred Floyd



One of the Fifth Prizes—Winifred Cramp

One of the Fifth Prizes—Hilda M. Kagi

One of the Fifth Prizes—Helen Barkhurst

1 carload in 5 goes up in SMOKE
20% of our coal is wasted through imperfect combustion. Save this fuel for war purposes by smoke abatement.
Fuel is Vital—Don't waste it!

One of the Fifth Prizes—Anderson

War Service of the Petroleum Industry*

By M. L. Requa

Director, Oil Division United States Fuel Administration

This war cannot be won without an ample supply of petroleum products. We must have, if we are to succeed, not only fuel oil, but gasoline, kerosene and lubricants as well; for them there are no known substitutes.

It is not possible to single out any one product and say of it, this is the most important for the winning of the war. We may say truly that the most important element is the spirit of the soul of the people, the morale of the nation, but in dealing with our industrial life we have absolute need of many things. Food we must have, or perish; steel, copper, chemicals, petroleum—we have need for all of these, and more, or we must suffer defeat. From the standpoint of the winning of the war, not one of these products is more important than petroleum. It lubricates the machinery of our transportation and manufacturing, it plows our fields, drives our vessels at sea and gives life to the airplane that watches over our soldiers and sailors.

As the application of steam and electricity grew, so grew the demand for more and better petroleum products. One to a large degree kept pace with the other. The original "puffing Billy" has grown into the Mallet compound of today; the original "Robert Fulton," wending laborious way down the placid Hudson, into the monster turbine-driven battleship. All these machines have been dependent upon lubrication, upon petroleum; and the more recent advances in marine construction have been predicated upon the use of fuel oil as the means of steam generation.

Rapid Rise of Internal-Combustion Engine

We have witnessed in the last decade the rise of the internal-combustion engine. Its profound effect on rural as well as urban life grows more and more manifest; it competes with the locomotive and the trolley as a means of rapid transit; and as a method of distributing freight in cities, plowing fields, and providing healthful recreation it is rapidly superseding the horse. As an instrument of war it is of paramount necessity; driving the swift-flying airplane that serves as the aërial scout to our armies; it makes possible observations for lack of which disaster would be the inevitable portion of our forces.

In the realm of the internal-combustion engine, petroleum reigns supreme. It supplies the motive power; it lubricates the machinery; it is, in short, the life fluid without which neither motor vehicle nor airplane could serve the needs of humanity.

The internal-combustion engine has created a demand for gasoline of hitherto undreamed-of proportions; it has made what was once considered almost a waste product into the most important element derived from petroleum distillation. Inability to supply the rising demand by recognized methods of refining has spurred inventive genius to new efforts, until today we have the new practice of pressure distillation with its resultant increase in gasoline output.

And what are our assets, with which to meet the demands which may be made upon us for petroleum? What is the strength of this young giant that responds to the nation's call to arms? We have produced from the year 1859 to date a total of more than 4,250,000,000 bbl. of oil. Our production has increased, by decades, from 500,000 in 1860 to 5,260,000 in 1870, 26,286,000 in 1880; 45,823,000 in 1890, 63,620,000 in 1900, 209,557,000 in 1910, and 330,000,000 in 1917. Over long periods the average increase has been about 7 per cent. of the previous year's production. At this rate of increase we shall require 460,000,000 bbl. per annum in 1927; and for 1918, if the average holds good, we shall require an additional amount above last year's production of approximately 23,000,000 bbl. It will be forthcoming, of course; from the known fields, if necessary; and perhaps in part from new discoveries.

We are beginning to realize, however, that our resources are not limitless. It is the consensus of opinion that the Appalachian, Lima (Indiana) and Illionis fields can add little in the way of increased production; leaving but three great known fields to meet our future requirements—Mid-Continent, Gulf and California.

The changes in the industry are startling; today a flow of oil, tomorrow a famine. Spindletop was discovered in 1901, and yet today the Southern Pacific brings oil from Mexico to supply its locomotives plying in Texas. We are confronted with constantly mounting consumption and a constantly increasing percentage of exhaustion. Some day the lines must cross, production will no longer be able to keep pace with consumption and we must seek other sources of supply.

Exact Extent of Future Supplies Unknown

Any mathematically exact estimate of the petroleum yet to be extracted from the rock formations of the United States is, of course, impossible. Undeveloped areas now unknown may add greatly to present estimates. Speaking broadly, however, I think I am safe in saying that it is our duty to conserve most carefully our remaining stores. Locked in the earth, they are of course valueless. Do not misunderstand me or imagine that I am arguing against production, against wildcatting, against the individual effort having for its incentive an adequate reward. I believe all these things must be done. But I am also of the belief that increasingly efficient methods of combustion, lubrication and general conservation will materially alter practices that can be safely characterized as wasteful.

In viewing the petroleum industry from the Governmental standpoint, it necessarily means the viewpoint of national welfare in contradistinction to individual gain; it means the wise husbanding of our available resources so that they may last the greatest time, in contradistinction to producing the greatest quantity in the least time and converting into money the treasures of nature's storehouse.

With the exhaustion of our oil or its advance in price we have, of course, the alternative of producing oil from shale. That there are enormous areas of such shales in the United States is well known among geologists and others who have taken the pains to investigate. These shales will undoubtedly in time be mined for oil, but we must remember that to produce a quantity of oil equal to our present production we shall have to mine a daily tonnage of shale in excess of the tonnage of coal now mined daily. The magnitude of such an undertaking is obvious. It will not be the growth of a day, but of years. And it is likely that because of plentiful supplies of oil which may be brought to the United States by water—cheap oil from Mexico and Central America—it will be many years before these shales are utilized.

Present Necessities Call for Economic Discipline

The stern necessity that has imposed unparalleled economic discipline upon the people of Europe will not disappear or be forgotten with the coming of peace.

This is no time to quibble over technicalities, no time to debate the power of the Government to perform any proposed act. We are at war. The life of the nation is at stake. The preservation of our national existence is of such paramount importance that nothing else really matters, compared with that duty.

Each month during the war the priority demands of the Government will become more and more insistent, the duty of the citizen to supply those demands more and more clearly defined.

If zonal distribution of petroleum products is necessary to supply national needs, zonal distribution will be accomplished. If pooling of tank cars and ships will more efficiently meet national demands, those facilities will be pooled. If well-drilling supplies must be allocated to produce the greatest quantity of oil to meet the increasing demands for oil, well-drilling supplies will be allocated. If licensing of jobbers and others is necessary, they will be licensed. If the petroleum industry or any part of it is so unwise as to engage in profiteering, ways and means will be found to correct that condition. In short, whatever the national needs may be, everything that is necessary will be done to meet those requirements.

*From an address delivered at the Petroleum Congress, Chicago Ill., Mar. 29, 1918.

Twenty-Million-Dollar Power Extensions Urged

Recommending extensive hydro-electric development in the southern part of California at an expenditure of $20,000,000 within the next two years, to meet the increasing demands for power and light and for the conservation of fuel, the Railroad Commission of California has issued a decision in its investigation of the construction and operation of electric utilities during the emergency created by the war.

Specificially, the commission recommends that the Southern California Edison Co. take immediate steps for the carrying out of a comprehensive plan for the financing of approximately $15,000,000 for building power plants, that the Southern Sierras Power Co. construct its Rush Creek Bishop line, and the San Joaquin Light and Power Corp. insure the building of additional plants for the increase of facilities, or by purchase agreement, the maintaining of an adequate power supply for agricultural and industrial needs.

The Railroad Commission's investigation was state-wide, but the present decision deals only with the territory south of Merced, the northern part of the state to be considered later. The decision says that though considerable economy of oil would result from more complete interconnection and coöperation of hydro-electric plants, yet the war emergency demands that the corporations take immediate steps to build additional power plants to meet the constantly growing needs for power made by normal increase of manufacturing and agriculture and the special needs of war industries which are rapidly multiplying in California.

The southern part of the state, which is considered in the commission's recommendations, comprises that portion of the San Joaquin Valley south of Merced and served by the San Joaquin Light and Power Corp. and the Mt. Whitney Power and Electric Co., and southern California, which is served by the Southern California Edison Co., the Southern Sierras Power Co., the San Diego Consolidated Gas and Electric Co., the Los Angeles Gas and Electric Corp. and the City of Los Angeles.

The power produced by these companies in 1915 was approximately 930,000,000 kw.-hr., in 1916, 1,010,000,000 kw.-hr. and in 1917, 1,146,000,000 kw.-hr. Of this last amount 911,000,000 kw-hr. was produced by hydro-electric plants, the remainder by steam, requiring a total oil and gas consumption equivalent to 1,316,000 bbl. of oil. It is estimated that the growth in business due to the normal developments and the special war industries will approximate 140,000,000 kw.-hr. per year, and a requirement of plant capacity of about 25,000 kw. and then, in order to keep down the oil consumption of electric utilities to that existing in 1917, will require that amount of development each year.

Economical Effects of Interconnection

The report shows that considerable economy will result from the interconnections now existing and those contemplated by the companies, but even with that saving it will be necessary to increase the hydro-electric facilities at least 20,000 kw. of useful capacity a year, and increase the energy output approximately 140,000,000 kw.-hr. under ordinary rainfall conditions. Consideration was given to the City of Los Angeles existing and proposed developments in connection with the aqueduct, where it appears that at a cost of between $2,500,000 and $3,000,000 the city would produce an additional peak capacity of 36,000 kw.-hr. and an output of at least 150,000,000 kw.hr. a year, resulting in a reduction of oil consumption of 600,000 bbl. a year.

The commission states that the development by the city would be largely completed within twelve months if priority orders were obtained for equipment, but that difficulties exist which apparently make it impossible at this time to count on the development of the plant. These difficulties arose from the fact that the City of Los Angeles contends that it cannot utilize bonds already authorized for the development of hydro-electric plants, but that this money must be used for the construction of distribution systems. The city believes that if a satisfactory agreement could be entered into with the Los Angeles Gas and Electric Corp. whereby that company would lease to the city its entire system, such agreement to contain an option for purchase by the city, the money authorized would be used for hydro-electric plants.

The Los Angeles Gas and Electric Corp., however, declines to consider the plan, which it contends constitutes a complete surrender of the possession of its distribution system to a competitor, and also that its trust-deed provisions make such a plan a legal impossibility.

The commission states that special pains were taken to attempt a solution of the problem, but that failure attended such efforts. It says that it has no authority or desire to order the city to develop the plants or deliver the power to the Los Angeles Gas and Electric Corp., nor authority to compel the Los Angeles Gas and Electric Corp. to accede to the proposition of the city.

The commission states: "It is to be seriously regretted that at this critical period, when conservation of fuel oil is one of the most important war needs, the give-and-take spirit should not be more in evidence and that all interests are not subordinated to actual war necessity."

Reported Power Possibilities

The commission discusses the reported power possibilities of the Southern California Edison Co., the San Joaquin Light and Power Corp., and the Southern Sierras Power Co., stating that the Southern Sierras Power Co. has two possible developments amounting to 17,500 kw. capacity in Mono and Inyo Counties which might be developed, but upon which sufficient funds are not available. It also states that the San Joaquin Light and Power Corp. has certain small developments that are being installed, but that definite information on any large developments has not been presented at this time. It urges, however, that the corporation give serious consideration to adding to its plants so as to meet requirements on its own system.

The Railroad Commission has authorized the San Joaquin Light and Power Corp. to issue $767,000 six per cent. first and refunding bonds payable in 1950. The money is needed, says the company, to buy property, construct, expand and improve its service and facilities.

The Sierra and San Francisco Power Co. has filed with the Railroad Commission an application for authority to issue $1,000,000 of its first-mortgage 5 per cent. bonds, the proceeds to be used for the construction of additional hydro-electric plant capacity on the middle fork of the Stanislaus River, the construction of storage reservoirs on the middle or south fork of that river, and the construction of additional flumes, ditches, etc.

The Mt. Whitney Power and Electric Co. has asked for approval of the Railroad Commission of a plan under which applicants for power will be required to advance a part of the cost of building the lines necessary to serve those making the application. The company states in its application that it will have to expend during 1918 upon its system $108,000 and that in addition to this sum it will have to spend $216,000 for the construction of extensions to care for new consumers, which the company estimates will be in the neighborhood of 4000 during 1918. The greater part of the new consumers will require power for agricultural purposes in the Counties of Kern, Kings and Tulare. The company is in doubt whether it will be able to dispose of its stock and bonds and says that it will have only approximately $600,000 available for the construction of extensions and consequently it is asking those seeking service to bear a portion of the expense of installation.

The Southern Sierras Power Co. has joined with the Corona Gas and Electric Co., the Bishop Light and Power Co., the Rialto Light, Power and Water Co. and the Coachella Valley Ice and Electric Co. for authority for the last-named four companies to sell their plants to the Southern Sierras Power Co.

The prices for these are respectively: $135,914; $60,576; $24,915 and $821,687.

Said B. T. Yew to C. O'Two,
"I work best when I work with you."
Said C. O'Two to B. T. Yew,
"When we are scarce the steam is, too."—*Fecony.*

All After Higher Rates

Electric light and power companies throughout the country are doing their best to obtain a higher rate—not, it is believed, that they are operating at a loss below actual operating expenses, but because they require a greater revenue in order to maintain their profits at about pre-war percentages. In many cases the demand for increased revenue has been granted in whole or in part by the public service commissions; in others the courts have refused increase, and other demands are still to be decided; franchises with "during the period of the war" charges, permitting of an increased rate, are declined, and others hold that contracts are mere "scraps of paper."

Recently, an electric-light franchise was granted to the Arkansas Light and Power Co., by the City of Clarendon, Ark. This franchise carried a 15 per cent. advance for the period of the war over the previous rate. It was rejected by the company for the reason, it is said, that the rate was not high enough on account of the advanced prices of materials and the cost of operating the plant.

Coming further east, the Cleveland Railway Co., Cleveland, Ohio, was not satisfied with existing rates and contemplated increasing trolley fares on Apr. 1. But this was not to be, as it is understood that Common Pleas Judge Pearson has granted the city an injunction restraining the railway company from increasing car fare as it had planned. Judge Pearson ordered the company to arbitrate with the city the necessity for an increase of fare. The increase the company sought to make called for a four-cent fare, seven tickets for a quarter, with the penny transfer charge rebated. The present fare is four cents, six tickets for twenty cents, and a penny charge for a transfer.

Journeying still further east, the transportation companies of New York City are desirous of a six-cent fare. Although the Cleveland Co. wants to charge but a four-cent fare and sell six tickets for twenty cents, New Yorkers have never even had a chance to purchase tickets at reduced rates. If one city can operate street cars for a four-cent fare, why cannot another is the question that many are asking.

When it comes to living up to contracts, some companies evidently look upon them as mere scraps of paper. For instance, the Public Service Corporation of New Jersey has a fight on its hands with the Manufacturers Council of the state. The council, representing hundreds of manufacturers throughout the state, contends that the abrogation of power contracts entered into by the corporation with numerous manufacturers is clearly illegal and that the corporation's notice to many consumers of the cancellation of these contracts is therefore without force.

The Public Service Corp., it will be remembered, canceled its contracts for power last winter when the coal shortage became so acute that it was almost impossible to generate electricity. There was no dissension heard then, and it was assumed that the manufacturers were willing to comply. The council's action furnished the first inkling that there was any objection.

It will be the aim of the council to take concerted action in behalf of those manufacturers who feel that they are aggrieved and who have been compelled, in order to insure a continuance of the power necessary for operating their plants, to submit to greatly increased rates.

Liberty Loan Committee for Machinery and Machine Tool Trades

A special Liberty Loan Committee for the machinery and machine-tool trades has been organized, with headquarters at 334 Fourth Avenue, New York City. The full personnel of the committee follows:

J. W. Lane, chairman, President, E. W. Bliss Co.; R. L. Patterson, vice-chairman, Pres. American Machine & Foundry Co.; Charles B. Houston, secretary, E. W. Bliss Co.; Norman Dodge, director of speakers, Vice-Pres. Mergenthaler Linotype Co.; Charles A. Hirschberg, publicity director, Publicity Mgr. Ingersoll-Rand Co. Committee: M. H. Avram, Slocum, Avram & Slocum; L. Barron, Sec. De La Vergne Machine Co.; Leigh Best, Vice-Pres. American Locomotive Co.; R. K. Blanchard, Neptune Meter Co.; G. D. Branston, Treas. Manning, Maxwell & Moore; Arthur W. Buttenheim, Pres. McKiernan-Terry Drill Co.; W. L. Callister, W. L. & J. T. Callister; De Courcey Cleveland, Pres. Central Foundry Co.; C. Philip Coleman, Pres. Worthington Pump & Mach. Corp.; C. I. Cornell, Treas. Pratt & Whitney Corp.; F. W. H. Crane, Pres. R. Hoe & Co.; J. J. Cuehler, Pres. Columbia Mach. W. & M. Iron Co.; C. G. Curtis, Pres. Curtis Turbine Co.; A. Davis, Pres. Davis-Bournonville Co.; F. S. De Lano, Treas. American Car & Foundry Co.; H. H. Doehler, Pres. Doehler Die Casting Co.; George Doubleday, Pres. Ingersoll-Rand Co.; F. F. Fitzpatrick, Pres. Railway Steel Spring Co.; Henry Fuller, Vice-Pres. Fairbanks-Morse Co.; P. H. Gill, Pres. P. H. Gill & Sons; R. E. Gilmore, Gen. Mgr. Sperry Gyroscope Co.; D. H. Haynes, Treas. American Machine & Foundry Co.; J. H. Hayward, Treasurer Hayward Co.; W. T. Hunter, Sec. A. Schrader's Son, Inc.; Isaac B. Johnson, Pres. Isaac G. Johnson & Co.; J. C. Kelly, Pres. National Meter Co.; W. P. Kethart, Sec. H. D. Berner & Winterbauer Co.; Hy. C. Knox, Treas. American Brake Shoe & Foundry Co.; John Lidgerwood, Pres. Lidgerwood Mfg. Co.; T. Frank Manville, Pres. H. W. Johns-Manville Co.; T. J. Menten, Vice-Pres. Schaeffer & Budenberg Mfg. Co.; Edward T. Morse, Sec. & Gen. Mgr. Morse Dry Dock & Repair Co.; C. E. Murray, Pres. Metropolitan Engineering Co.; Henry Prentiss, Pres. Prentiss Tool & Supply Co.; Joseph T. Ryerson, De Mant Tool & Machine Co.; E. A. Stillman, Pres. Watson-Stillman Co.; H. R. Swartz, Pres. Intertype Corp.; Charles Taylor, Clark, Dodge & Co.; Herbert G. Thomson, Pres. Anchor Post Iron Works; J. M. Turner, Pres. General Acoustic Co.; J. H. Walbridge, Pres. Lalance & Grosjean Mfg. Co.; J. Harvey Williams, Pres. J. H. Williams & Co.; J. B. Wing, Treas. Dexter Folder Co.

Progress of the Public Service Commission's Rate Hearing

Further evidence to show the economy of the isolated plant for combined lighting and heating was given on Apr. 8 at the resumed hearing before the Public Service Commission for the First District of New York. This evidence was based on the records of the steam plant in the Fifth Avenue Building, of which David Larkin is chief engineer.

According to the testimony of Mr. Larkin, the building occupies a plot approximately 236 ft. by 286 ft. and contains about 540,000 sq.ft. of floor space. It is mainly an office building, but the ground floor is occupied by stores and restaurants; in addition, the Aldine Club is located in the building. The service demanded of the plant is the furnishing of electric current for lighting and steam for heating, as well as the necessity of supplying live steam at a pressure of 40 lb. per sq.in. to the Aldine Club and the restaurants all the year round.

The relative costs of operation by private plant alone and by a combination of Edison service and private plant were determined from the records of the plant for the years 1916 and 1917. For 1916 the balance was $26,000 in favor of the private plant, and for 1917 it was $17,000 in favor of the private plant. In other words, these amounts show the additional costs that would have been incurred if the current for lighting had been purchased from the Edison company and the private plant had been used merely to furnish the steam required for heating and for the use of the restaurants and the Aldine Club.

As to the actual saving of coal, the figures were likewise in favor of the operation of the isolated plant alone. In 1916, which was considered an average year, the saving was estimated at 300 tons over that which would be required by combined Edison service and private-plant operation. In arriving at this result, it was assumed that the central station would burn 3 lb. of coal per kilowatt-hour delivered to the customer.

At the conclusion of Mr. Larkin's testimony, the hearing was adjourned until Apr. 29.

The French and British have nobly stood behind their governments in war loans. Where do you stand?

New Publications

STEAM TABLES FOR CONDENSER WORK

The Wheeler Condenser and Engineering Co., Carteret, N. J., announces that the fourth edition of its steam-table handbook is off the press, making a total of 20,000 copies. One reason why this handbook has met with such success is that the pressures below atmosphere are expressed in inches of mercury referred to a 30-in. barometer. Another is that it is complete. It includes a discussion of the mercury column, the errors in such measurements, and constants for their correction. A complimentary copy will be furnished on request to those in responsible positions who are not yet provided with a copy and who deal with steam and its many problems.

Personals

Henry D. Jackson, formerly of Timothy W. Sprague and Henry D. Jackson, consulting engineers, 88 Broad St., Boston, Mass., has joined the organization of Monks & Johnson, engineers and architects, 78 Devonshire St., Boston, as power engineer, taking charge of their power-plant and heating work.

R. W. Spofford, general manager of the Augusta-Aiken Railway and Electric Corporation, Augusta, Ga., who is a retired officer of the United States Navy, has been called to active service. W. C. Callaghan succeeds him as general manager. Mr. Callaghan has been with the J. G. White Management organization, New York City, the operators of the Augusta company, since 1913.

Engineering Affairs

The American Association of Engineers and the Committee on Engineering Co-operation will hold a joint annual meeting at the City Club, Chicago, on May 14. All technical societies are invited to send one or more delegates to this meeting.

Miscellaneous News

A Peculiar Flywheel Accident—In a rolling mill a number of circular billets were piled up in line with the pit of a 30-ft. flywheel. The removal of one of the billets in the lower row set the others to rolling. One of them rolled into the wheel pit and completely wrecked the large flywheel.

A Mortgage Has Been Filed in the office of the county clerk, Eugene, Ore., and executed by the Mountain States Power Co. in favor of the Illinois Trust and Savings Co., of Chicago. The amount of the bonds covered by the trust mortgage is $2,353,000 of an authorized issue of $15,000,000. The Mountain States Power Co. is the reorganized Northern Idaho and Montana Power Co. which operates it. The property covered by the mortgage is that located in various counties of Oregon and used by the Oregon Power Co.

Electric Service for Camp Perry—The Northwestern Ohio Railway and Power Co. will furnish electric service for Camp Perry. The later news with reference to the camp indicates that it is to be a cantonment capable of accommodating approximately 9000 soldiers who will be trained in target practice, both artillery and short-range rifle shooting, with moving targets. It is also to be used as an aviation training ground. Options have been taken on about 1600 acres in addition to the land already used for camp purposes.

The Municipal Civil Service Commission has announced an examination for mechanical draftsmen (electrical), Grade C (male and female), for which applications will be received at Room 1400, Municipal Building, Manhattan, until Apr. 25, at 4 p. m. Subjects and weights: Experience, 2; technical, 6; mathematics, 2. Candidates must be 21 years of age or over, must be citizens of the United States and residents of New York State; will be required to prepare drawings and to do other related work, such as computing, compiling data and plotting in connection with electrical installations for power and lighting. Applicants should have training and experience as a mechanical draftsman such as to qualify them for the position. They must have had actual experience in laying out, computing, drafting or other related work incident to the construction or operation of light and power or similar experience. They should have a good knowledge of the Electrical Code. Salary from $1200 to $1800 per annum.

Business Items

H. W. Johns-Manville Co.'s Youngstown (Ohio) office is now located at No. 520 Market St.

The Homestead Valve Manufacturing Co., of Homestead, Penn., has opened a branch office at No. 1 Franklin St., New York City.

The Brown Instrument Co., of Philadelphia, Penn., has let a contract for an addition to its factory to cost approximately $50,000.

The Yarnall-Waring Co., in order to obtain even greater benefit from a widely established reputation for efficient power plant accessories, has decided to group its several products under the family name of "Yarway."

The Machinery Sales Department, operated by the Merchants and Manufacturers Exchange of New York, is now establishing a permanent machinery exhibit and salesroom at Grand Central Palace, 46th to 47th St. and Lexington Ave., New York City, where prospective buyers may be shown up-to-date machinery and mechanical appliances, get first-hand information and at the same time place their business. Machinery manufacturers and allied industries can rent suitable offices and exhibition space by communicating with the Machinery Sales Department, Grand Central Palace, New York. L. R. Duffield, formerly of the Philadelphia Bourse, is now in charge here.

Trade Catalogs

Rails, Etc. Walter A. Zelnicker Supply Co., St. Louis, Mo. Bulletin 237. Pp. 17; 3½ x 8¼ in.; illustrated. Free copy upon request.

Automatic Reclosing Circuit Breakers and Relays. The Automatic Reclosing Circuit Breaker Co., Columbus, Ohio. Bulletin No. 30, Pp. 20; 8¾ x 11 in.; illustrated; general description, theory and application.

The "De La Vergne" Counter-Current Ammonia Condenser. De La Vergne Machine Co., Foot of E. 138th St., New York. Bulletin No. 174. Pp. 8¾ x 11 in.; illustrated.

Pipe Tools. Greenfield Tap and Die Corp., Greenfield, Mass. Catalog No. 38. Pp. 32; 4¾ x 7¼ in. Describing and illustrating complete line of pipe tools made by the various divisions of this corporation. Copy mailed free upon request.

Link-Belt Roller Chain. Link-Belt Co., Chicago, Ill. Book No. 358. Pp. 16; 6 x 9 in.; illustrated. Giving information on recent roller-chain developments.

Motor Driven Compressors—Westinghouse and National Types. Westinghouse Traction Brake Co., Industrial Dept., Pittsburgh, Penn. Publication No. 9035. Pp. 113; 6¼ x 9¼ in. Describes and illustrates fully both lines of compressors and accessories, with complete information relative to sizes, capacities, ratings and dimensions, in tabulated form.

Diamond Soot Blowers. Diamond Power Specialty Co., Detroit, Mich. Bulletin 119. Pp. 48; 7¾ x 10⅜ in. A review of current mechanical soot-blower practice, fully illustrated; with data on boiler-room efficiency, insuluminium, venturi nozzles, etc. A copy of the bulletin will be furnished free upon request.

Reilly Steam Pumps and Air Compressors. National Foundry and Machine Co., Inc., Louisville, Ky., Vogt Bros. Manufacturing Co., of Louisville, are now exclusive manufacturers. Catalog No. 12. Pp. 160; 5½ x 7¾ in.; copiously illustrated with information covering the various types of pumps and compressors; many useful engineering tables; indexed.

Industrial Storage-Battery Locomotives. The Jeffrey Manufacturing Co., Columbus, Ohio. Catalog No. 231. Pp. 24; 6 x 9 in. This catalog contains interesting illustrations and description of various installations, and other useful data. A free copy may be obtained by writing to the company's main office or to any of its branch offices.

NEW CONSTRUCTION

Proposed Work

Mass., Canton—The Springdale Finishing Co. is having plans prepared by A. Wright, Arch., 73 State St., Boston, for a 2-story, 45 x 55 ft., reinforced concrete, steel and brick power house to be erected on Pine St. Estimated cost, $20,000. F. Meyer, Mgr.

Mass., Sherborn—The State will soon receive bids for the erection of an concrete power house and the installation of 1 new engine generator and 3 tubular boilers, etc. Estimated cost, $68,211. R. D. Kimball Co., 6 Beacon St., Boston, Engr.

Conn., Bridgeport—The United Illuminating Co. has been granted authority by the Public Service Commission to build a 3 conductor, 660 volt transmission line.

Conn., Thamesville (Norwich P. O.)—The Eastern Connecticut Power Co., c/o R. W. Perkins, Norwich, has had preliminary plans prepared by H. M. Hope Eng. Co., Engr., 185 Devonshire St., Boston, Mass., for the erection of a 1-story, 80 x 140 ft. brick power house here.

N. Y., Freeville—The Groton Electric Power Corporation, Groton, plans to build a new power plant here.

N. Y., Waterville—The Waterville Gas and Electric Co. has filed a petition with the Public Service Commission for authority to build and operate an electric distributing system here. R. Thomas, Ch. Engr.

N. J., Trenton—City plans to build a new 2-story, 26 x 300 ft. boiler plant in connection with the Municipal Hospital. Estimated cost, $85,000.

Penn., Newcastle—The Grasselli Powder Co., 589 Arcade, Cleveland, Ohio, will build a 1-story, 100 x 125 ft. brick, reinforced concrete and steel power house. Estimated cost, $100,000.

Penn., Parkesburg—The Parkesburg Iron Works plans to build an addition to its boiler house. Estimated cost, $18,000.

Md., Baltimore—The Consolidated Gas, Electric Light and Power Co., Lexington and Liberty St., Baltimore, will build a 4-story, 100 x 200 ft., concrete, steel and brick, boiler house at Westport. Estimated cost, $100,000. Noted Nov. 13.

Md., Mt. Airy—The Mount Airy Ice and Electric Co. plans to install an additional generating unit. C. C. Riddlemoser, Mgr.

N. C., Pine Level—The Citizens Power and Light Co. plans to build an electric transmission system connecting 2 towns and a substation in each one. C. L. Goodwin, owner.

N. C., Reidsville—City voted $10,000 bonds for extensions and improvements to its electric lighting plant.

S. C., Sumter—City plans to build an electric lighting plant.

Ga., Commerce—City plans an election soon to vote on $15,000 bonds for the erection of an electric lighting plant.

Ga., Macon—The Macon Gas Co. will expend about $40,000 for improvements to its plant. A. Magraw, Gen. Mgr.

Ga., Ty Ty—City voted $7000 bonds to build an electric lighting plant.

Miss. Fondren—The State Insane Hospital is in the market for two 250 hp. boilers, water heaters, traps, valves, feed water pumps, smoke stack, stokers, ash conveyers, etc., for its new boiler house. R. L. Paquette, Box 31, Ch. Engr.

Ohio, Cleveland—City will soon award the contract for the superstructure of a 1-story, 169 x 175 ft. power house to be erected on East 53rd St. High pressure boilers, 25,000 kw. generator, switchboards and other equipment will be installed. Estimated cost, $525,000. J. Tufal, East 53rd St. Station, Engr.

Ohio, Hamilton—The Hamilton and Rossville Hydraulic Co. plans to build a power plant in connection with a new plant soon to be erected. Stone & Webster, Engrs.

O., Lowellville—The Mahoning and Shenango Ry. and Light Co., 25-31 E. Boardman St., Youngstown, will build a transmission line from here to McDonald. R. T. Sullivan, Mgr.

Ohio, Ravenna—Portage Co. will soon receive bids for the erection of an electric transmission line from intersection of Ravenna-Mantua Rd. with east and west road 3 miles north of courthouse. Estimated cost, $1,521.

Ind., Attica—The Attica Electric and Power Co. has been authorized to issue $50,000 in stock and $50,000 in bonds for the erection of an electric light and power plant to replace one recently destroyed by fire.

Mich., Flint—The Citizens Hotel Co., Ellicott Sq., Buffalo, N. Y., is in the market for complete power equipment, 500 hp.

Ill., Homer—The Homer Electric Light and Power Co. plans to extend its transmission line from here to Fairmount. W. S. Thompson, Mgr.

Ill., Oaklawn—The Chicago and Eastern Illinois R.R., Chicago, is having plans prepared for the erection of an addition to its power house here. L. C. Hartley, 66th and Union Ave., Chicago, Ch. Engr.

Wis., Camp Douglas—The Orange Light and Power Co. plans to extend its transmission line from here to Hustler. A. M. Patterson, Mgr.

Wis., Eau Claire—The Sacred Heart Hospital is having plans prepared by Foeller & Schober, Engrs., 123 North Washington St., Green Bay, for the erection of a 40 x 95 ft. boiler house and laundry.

Wis., Markesan—The Wisconsin Power, Light and Heat Co., Milwaukee, has purchased the Omro Electric Light Co., Omro, and plans to extend the Kilbourn and Prairie du Sac transmission lines from here to Berlin and Omro. E. B. Hemibach, Supt.

Wis., Orfordville—The Orfordville Light and Power Co. plans to build a 4½ mi., 3 phase, 60 cycle, 6600 volt, transmission line. A. E. Tomlin, Secy.

Wis., Rewey—The Mineral Point Public Service Co. plans to build a 33,000 volt transmission line from here to Platteville to connect with lines of the Interstate Light and Power Co., Galena, Ill. J. C. Meiners, Milwaukee, Pres.

Iowa, Eddyville—City voted $8000 bonds for improvements to its electric lighting plant. Noted Jan. 15.

Iowa, Sioux City—The Phillip Bernard Co. plans to build a heating plant and factory warehouse north of its factory on Floyd Ave. Estimated cost, $100,000.

Kan., Luray—City will soon award the contract for the erection of an addition to its electric lighting plant. Plans include the construction of a new power house and the installation of equipment.

Kan., Rossville—The Rossville Electric Light and Power Co. plans to enlarge its plant and extend its transmission line to Delia, Silver Lake and Willard. J. W. Phares, Pres.

Neb., Beaver Crossing—City plans to issue $9000 bonds for the installation of an electric lighting plant.

Neb., Schuyler—City is having preliminary plans prepared by the Electrical Development Co., Sioux City, Iowa, for improvements to its electric lighting plant.

S. D., Blackwell—City voted to issue bonds for improvements to its electric lighting plant and water-works system.

Mo., Garden City—The Green Light and Power Co., Pleasant Hill, has purchased the plant of Kaufman & Son, and plans to build a transmission line soon.

Mo., Kansas City—The Southwestern Milling Co., Dwight Bldg., is in the market for 400 hp. power plant equipment.

Mo., Otterville—K. Starten plans to install an electric lighting plant here.

Tex., Humboldt—City plans to improve its electric lighting plant. Plans include the installation of a new 300 kw. turbine, condenser and auxiliaries. W. M. Case, Gen. Mgr.

Okla., Hartshorne—The Choctaw Power and Light Co., McAlester, has been granted a franchise to build and maintain an electric lighting plant here. W. H. Vorce, McAlester, Gen. Mgr.

Okla., Ryan—City plans to install a crude oil engine in its electric lighting and water-works plant. W. C. Willard, Gen. Supt.

Okla., Shawnee—C. Sells, Commissioner of Indian Affairs, Washington, D. C., will receive bids until Apr. 30, for the installation of a steam heating system in the Shawnee school.

Ariz., Phoenix—The State Hospital for Insane has plans under way for the erection of a power house.

Wash., Bremerton—The Bureau of Yards and Docks, Navy Dept., Wash., is in the market for 2 turbo generators. Estimated cost, $90,000.

Wash., Hoquaim—The Lamb Machine Works plans to install an electric steel furnace in its proposed foundry and machine shop.

Wash., Spokane—The Loon Lake Copper Co. plans to install electric motors to operate all mining equipment. F. G. Crane, Secy.-Treas.

Ore., Mapleton—The North Star Power Co. plans to build 2 miles of transmission line.

Ore., Portland—The Electric Steel Foundry, 24th and York St., plans to build a transformer station at its plant here.

Calif., Corcoran—The San Joaquin Light and Power Co., Fresno, plans to install an electroller lighting system on Whitley Ave. G. Wilson, Fresno, Gen. Mgr.

Calif., Redding—The Shasta Land and Timber Co. of Redding plans to rebuild its electric power plant and planing mill which was recently destroyed by fire. Loss about $45,000.

Ont., Alvinston—City plans to install power machinery.

CONTRACTS AWARDED

Conn., North Grosvenordale—The Grosvenordale Co. has awarded the contract for building, rearranging and altering its electric power station, to the J. W. Bishop Co., Worcester, Mass. Estimated cost, $30,000.

N. Y., Rochester—The Department of Public Works has awarded the contract for the erection of a new power house, to J. Friedericks & Son, Rochester, $12,739. Pumping machinery, engines, etc., will be installed. Noted Feb. 19.

Penn., Clifton Heights—The Kent Manufacturing Co. has awarded the contract for equipment as follows: coal conveyors, to R. H. Beaumont & Co., Drexel Bldg., Philadelphia, Pa., $7,500; boilers, to the Union Iron Works Co., Bourse St., Philadelphia, Pa., $20,000; pumps to the American Steam Pump Co., Commercial Trade Blk., Philadelphia, Pa., $1600. Noted Mar. 26.

S. C., Charleston—The Charleston Consolidated Ry. and Lighting Co. is building a 500 kw. rotary substation near the Navy Yard.

Ohio, Cleveland—The Steel Products Co., 2196 Clarkwood Rd., is having plans prepared by Burchard Roberts & Wales Co., Engrs., 622 Swetland Bldg., for a 1-story, 50 x 100 ft. heating plant to be erected on East 65th St. Estimated cost, $15,000.

Ohio, Columbus—The Ohio University has awarded the contract for the installation of a 6 retort boiler for the new power plant, to the Underfeed Stoker Co. of America, 111 West Monroe St., Chicago. Noted Oct. 30.

Ohio, Sandusky—The Good Samaritan Hospital has awarded the contract for the installation of electrical apparatus and fixtures, to the Bonn Electric Co. Estimated cost, $10,000.

Wis., Ashland—The Ashland Light, Power and Street Railway, 212 West 2nd St., is building a new hydro electric plant at Superior Falls. Estimated cost, $100,000. Noted Oct. 16.

Wyo., Lusk—The town has awarded the contract for the installation of a 100 hp. semi-Diesel oil engine, a 60 kv.-a., 60-cycle, 3 phase, 2300 volt generator, directly connected, and a 20 hp. motor for water-works, to the Fairbanks-Morse Co., 13th and Liberty St., Kansas City, Mo.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular Apr. 11, 1918	Individual Apr. 11, 1918
Buckwheat	$4.60	$7.10—7.35
Rice	4.10	6.65—6.90
Boiler	3.90	.....
Barley	3.60	6.15—6.40

BITUMINOUS

Bituminous not on market.

Pocohontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.00 a year ago.

*All-rail to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular Apr. 11, 1918	Individual Apr. 11, 1918
Pea	$4.90	$5.65
Buckwheat	4.45@5.15	5.10@5.85
Barley	3.40@3.65	3.10@4.10
Rice	3.90@4.10	4.10@4.85
Boiler	3.65@3.90	.....

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Gross	Mine Price Net	Gross
Central Pennsylvania	$5.06	$3.05	$3.41
Maryland—			
Mine-run	4.84	2.85	3.19
Prepared	5.06	5.05	3.41
Screenings	4.50	2.55	2.85

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The ratte to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Apr. 11, 1918	One Yr. Ago	Apr. 11, 1918	One Year Ago
Pea	$3.75	$2.80	$4.65	$3.70
Barley	2.15	1.85	2.40	2.05
Buckwheat	3.15	2.50	3.75	3.40
Rice	2.65	2.10	3.65	3.00
Boiler	2.45	1.95	3.55	3.15

Chicago—Steam coal prices f.o.b. mines:

Illinois Coals	Southern Illinois	Northern Illinois
Prepared sizes	$2.65—2.80	$3.35—3.50
Mine-run	2.40—2.55	3.10—3.25
Screenings	2.15—2.30	2.85—3.00

Smokeless Coals	So. Ill., Pocohontas, Pennsylvania and W. Va.	Hocking, East Kentucky and West Va. Splint
Prepared sizes	$2.60—2.85	$2.85—3.35
Mine-run	2.40—2.60	2.60—3.00
Screenings	2.10—2.55	2.35—2.75

St. Louis—Prices per net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties April 11, 1918	Mt. Olive & Staunton April 11, 1918	Standard April 11, 1918
6-in. lump	$2.65-2.80	$2.65-2.80	$2.65-2.80
2-in.-lump	2.65-2.80	2.65-2.80	2.65-2.80
Steam egg	2.65-2.80	2.65-2.80	2.65-2.80
Mine-run	2.45-2.60	2.45-2.60	2.45-2.60
No. 1 nut	2.65-2.80	2.65-2.80	2.65-2.80
2-in. screen	2.15-2.30	2.15-2.30	2.50-2.65
No. 5 washed	2.15-2.30	2.15-2.30	2.50-2.65

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump & Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona	2.15	2.40	1.90
Black Creek, Cahaba	2.40	2.65	2.15

Government figures.

Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.